

Western Snowy Plover Nesting at Bolsa Chica, Orange County, California 2022



Snowy plover (Gb:ak) that nested and fledged one chick at Bolsa Chica Ecological Reserve in 2022 after being previously oiled in the 2021 Huntington Beach Oil Spill. Photo by Brian Daniels, 2022

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EXECUTIVE SUMMARY

This is the 26th year of annual reporting on nesting western snowy plover at Bolsa Chica Ecological Reserve (Reserve). The first report covering the 1997 breeding season was initiated by Jack Fancher of the U.S. Fish and Wildlife Service as part of the planning for the Bolsa Chica Lowlands Restoration Project, which reintroduced tidal influence to the Reserve, a project completed in 2006.

In 2022, Peter Knapp (California Department of Fish & Wildlife) and volunteer Ross Griswold continued annual monitoring and management of western snowy plovers at the Reserve. New in 2022, preparation of the site for nesting included placement of 25 gravel pads to attract plovers to nest. From mid-February to mid-September, nesting surveys were conducted daily or twice daily. Observers documented the location of any new nests, installed welded-wire mini-exlosures (ME) over each nest to protect it from predators, monitored the nests each day, and later followed each brood until fledging. In addition, a range-wide Winter Window Survey and a Breeding Season Window Survey were conducted. The minimum number of adults present at Bolsa Chica during the breeding season was also calculated using the Estimated Minimum Number of Adults method.

The 2022 breeding population rebounded from 2021's population of 66 adults to a 2022 population of 114 and exceeded the previous 5-year average population of 104.

The first snowy plover nest was established on March 25, which was two weeks earlier than 2021. The last brood fledged on September 10. There was a total of 115 nests, producing 329 eggs, of which 283 hatched chicks, with 110 fledglings produced. Of the 115 nests, 61 nests fledged at least 1 chick. There was an overall fledge rate (fledglings/male) of 1.57, reflective of an increasing population in 2022. This was an increase from the fledge rate of 1.20 in 2021.

A high rate of chick loss in 2022 (173 chicks or 71% of all chicks) continued similar losses observed each year since 2017. After no predator management in 2019 and 2020, some predator control was instituted late in the 2021 season. In 2022 predator management was present on a limited basis and achieved some success with corvids, while kestrel control was limited. By the time it was discovered that great horned owls presented a lethal threat to nesting plovers in 2022, funding for predator management was exhausted. Concentrated predator management for the full breeding season is essential at Bolsa Chica. Funding is yet to be identified for 2023 predator control.

Cameras were used extensively in 2022, following their initial use in 2021. The primary goal of camera use was to determine the cause of nest abandonment by plovers and secondarily to observe predator species and activity. The camera data revealed that in three instances a great horned owl took a plover adult and the nest was subsequently abandoned by the remaining adult. This evidence is new and valuable information that will inform plover management decisions at the Reserve.

The most utilized regions of Bolsa Chica for snowy plover nesting were the Muted Tidal Basin and the Seasonal Ponds with 35% and 36% of all nests, respectively. The productivity of the Muted Tidal Basin continued to be high in 2022, producing 61% of all fledglings. The Muted Tidal Basin is critical to nesting plovers at Bolsa Chica. Planning efforts to remedy the hydrologic failures of the Full and Muted Tidal Basins should consider the impact that higher water levels would have on nesting plovers in the Muted Tidal Basin. The man-made nest sites continued to have low nesting numbers, likely due to the previously identified problems with increased vegetation on these sites.

The range-wide Winter Window Survey conducted in January 2022 to estimate the winter population size found 28 adults within the Reserve. The range-wide, Breeding Season Window Survey conducted on May 24 resulted in a count of 72 adult snowy plovers in the Reserve. Using the calculated Estimated Minimum Number of Adults method, the adult population was determined to be 114. The reason for the disparity between the methods is unknown, however it is typical to have disagreement between the two numbers. We believe the Minimum Number of Adults Methodology is the more effective method for determining the size of the breeding population and only continue the Breeding Season Window Survey for the U.S. Fish and Wildlife Service. Both the Breeding Season Window total of 72 adults at the Reserve, and the 114 adults calculated by the Estimated Minimum Number of Adults method, met the management goal of 70 adults in the breeding season, as specified in the U.S. Fish and Wildlife Recovery Plan for the Pacific Coast Population of the Western Snowy Plover.

While not covered by this report, we note that western snowy plovers continued to nest on both Huntington (9 nests) and Bolsa Chica (1 nest) State Beaches in 2022.

INTRODUCTION

Bolsa Chica is a coastal lowland area between two mesas, the Bolsa Chica Mesa and the Huntington Beach Mesa in Orange County, California (Figure 1). Bolsa Chica, which a century ago was under full tidal influence, has started to come full circle. Over 100 years ago, Bolsa Chica was diked-off from direct tidal influence but remained below mean sea level, becoming influenced by freshwater and acted as a sump for local drainage. In 1978, restoration began on the State's Ecological Reserve, and muted tidal influence was restored to the Inner Bolsa Bay area. At that time, two small islands, North Tern Island and South Tern Island, were created for nesting California least tern (*Sternula antillarum browni*), a State and Federal endangered species.

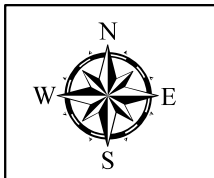
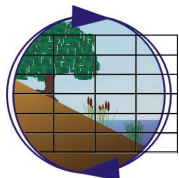
In 1997, the Bolsa Chica lowlands were acquired into public ownership. This marked the beginning of a multi-agency effort to design, evaluate, and implement a plan for restoring the fish and wildlife habitats. These habitats had been cut off from the ocean for a century and had been an operating oil field for over 50 years. Construction of the restoration project began in fall 2004 and was completed in August 2006. By the 2006 breeding season, three new nest sites were available for nesting and augmented the pre-existing North and South Tern Islands in Inner Bolsa Bay. The new ocean inlet, referred to as the Full Tidal Basin, was opened after the conclusion of the breeding season on August 24, 2006 and is now subject to water level rise and fall that approximates the unequal semi-diurnal tidal range of southern California's ocean waters. The MTB was opened to tidal influence from the Full Tidal Basin through its water control structures in March 2008, but the east and central MTBs have never functioned as designed. The first report on western snowy plover nesting at Bolsa Chica was prepared by Jack Fancher of the U.S. Fish and Wildlife Service and reported on the 1997 breeding season.

The purpose of this investigation is to continue to improve the level of knowledge about the western snowy plover (*Charadrius nivosus nivosus*), a federally listed, threatened species that currently uses Bolsa Chica, and to attempt interim management actions to benefit the reproductive success of this species. This annual study will also aid in documenting achievement levels required to meet the goals of the Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (U.S. Fish and Wildlife Service 2007). In addition, this study will aid in assessing the long-term effect of the restoration project and identify any modifications that would enhance utilization and increase reproductive success of the western snowy plover. This annual study was first initiated in 1997. This document reports on the 2022 snowy plover breeding season at Bolsa Chica. It is recommended that the reader make sure to review the Management Recommendations on page 23.

BACKGROUND

The western snowy plover is a sparrow-sized, white and tan colored shorebird with dark patches on either side of the neck, behind the eyes, and on the forehead. The coastal western snowy plover population is defined as those individuals that nest adjacent to or near tidal waters and includes all nesting colonies on the mainland coast, peninsulas, offshore islands, adjacent bays, and estuaries. The breeding range of the coastal population of the western snowy plover extends along coastal beaches from the southern portion of Washington State to southern Baja California, Mexico. The Pacific coast population of the western snowy plover is reproductively isolated from the interior populations.

The recognized breeding season of the western snowy plover normally extends from March 1 through September 15; however, there are exceptions. In 2009, the first nest at Bolsa Chica occurred on February 23, and courting behavior has been observed as early as late January. Generally, three



Site Locator and Vicinity Map
 Bolsa Chica Lowlands Restoration Project
 Orange County, CA

Figure 1

eggs are laid in a nest on the ground, which consists of a shallow depression scraped in the substrate. Some nests are lined with plant parts, small pebbles, or shell fragments.

Both sexes incubate the eggs for an average of 27 days. Snowy plovers will renest after loss of a clutch or brood. Snowy plover chicks are precocial and leave the nest within hours of hatching in search of food. The tending adults provide danger warnings, thermo-regulation assistance, and guide the chicks to foraging areas, but do not provide food to their chicks. Broods rarely stay in the immediate area of the nest. Young birds are able to fly within approximately 28 to 31 days of hatching.

Double brooding and polyandry are typical for this species. Snowy plover females usually leave very young chicks with the male in order to find another mate. The male typically tends the brood until the chicks fledge. Western snowy plover adults and young forage on invertebrates and insects along intertidal areas, beaches in wet sand and surf cast kelp, foredune areas of dry sand above the high tide, on salt panne, and edges of salt marshes and salt ponds (Page et al. 1995). The snowy plover is primarily a run and glean type of forager.

Poor reproductive success resulting from human disturbance, predation, and inclement weather, combined with permanent or long-term loss of nesting habitat to urban development has led to the decline in active nesting colonies as well as an overall decline in the breeding and wintering population of the western snowy plover along the Pacific coast of the United States. In southern California, the very large human population and the resultant beach recreation activities by humans have precluded the western snowy plover from breeding in several historically used beach strand areas. As a result of these factors, the Pacific coast population of the western snowy plover was federally listed as threatened with extinction on March 5, 1993 (Federal Register 1993).

BOLSA CHICA STUDY AREA

Snowy plover nesting areas within Bolsa Chica include: Seasonal Ponds (Cells 2 through 13), Future Full Tidal Basin (FFTB) (Cells 14 through 40 and Cell 63), Muted Tidal Basin (MTB, Cells 41 through 50 and Cell 66), the service roads that divide the cells, North Tern Island (NTI), South Tern Island (STI), Nest Site 1 (NS1), Nest Site 2 (NS2), Nest Site 3 (NS3), and the Levee Roads of the Full Tidal Basin (Figure 2). Some areas in the vicinity of the Bolsa Chica study area were not surveyed in this study, including Outer Bolsa Bay, Rabbit Island, and Inner Bolsa Bay to the west of the West Levee Road with the exception of the NTI and STI (Figure 2). The ocean beach immediately west of the Reserve, Bolsa Chica State Beach, was regularly surveyed for plover nesting by others, but is not included in this study other than to report nesting numbers.

The Seasonal Ponds, FFTB, and MTB are demarcated into subareas (cells) by the network of slightly elevated roads constructed decades ago for access to the oil wells. These cells were numbered and form the basis for observer navigation, nest mapping, and data recording. Each cell is unique in configuration and area. For the purposes of plover monitoring, Cells 22 and 23 are combined and have been reported in the past as simply Cell 22. The position of nests in either Cell 22 or 23 can be seen on Figure 2 each year. The approximate areas of some key cells are: Cell 10 (17 acres) and Cell 11 (54 acres).

The Seasonal Ponds are predominantly salt panne, and the most dominant plant species is pickleweed (*Sarcocornia pacifica*). Portions of the ponds are seasonally inundated with fresh to brackish water that becomes highly saline as evaporation concentrates the remaining water in diminishing pools over the salt panne. Beginning in 2012, ocean water was introduced into Cells 11, 12, 13, 14, 19, and 22

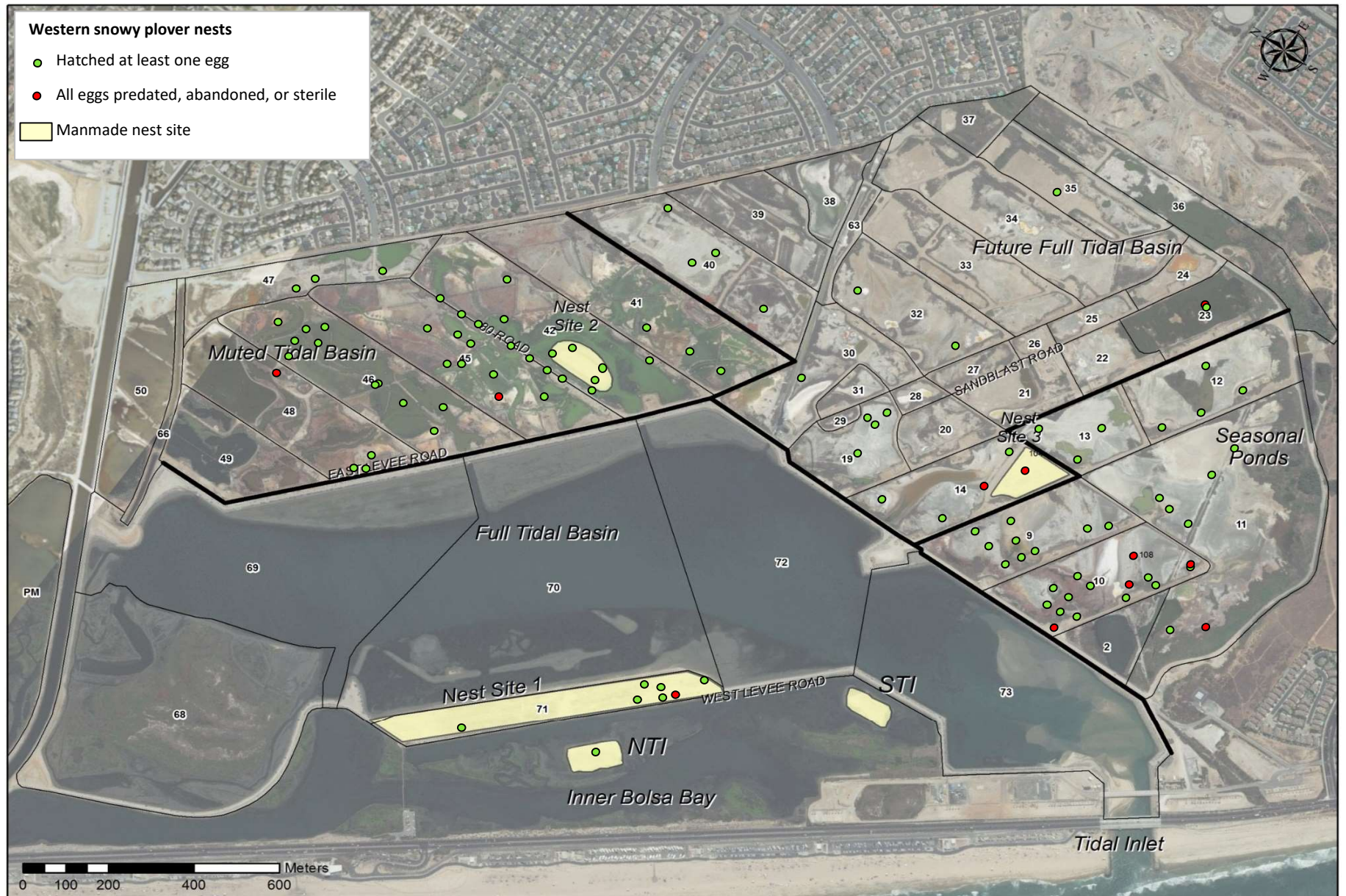


Figure 2. Western Snowy Plover Nest Locations at Bolsa Chica Lowlands, 2022

from the Full Tidal Basin in early fall in order to provide habitat for the wintering waterfowl and to control encroachment of reed growth in Cell 11. This is now common practice.

The FFTB lies between the Seasonal Ponds and the MTB and consists of salt panne and some pickleweed, although there is one cell that retains water year-round (Cell 30). Most of the FFTB is suboptimal for nesting, though some cells have seen increasing numbers of nests over the past decade.

The MTB occupies the northeastern section of Bolsa Chica and is divided into west, central, and east basins. Muted tidal influence was introduced to the west MTB in March 2008, and later to the central and east basins in March and May 2011, respectively. Due to continued tidal muting in the Full Tidal Basin in 2022, the central and eastern MTBs remained non-tidal. They receive overflow from the west MTB, leakage from their gates, and rainfall. This tends to result in high water levels in the winter when water spreads beyond the excavated tidal channels, and low water levels in the summer where water is generally restricted to channels. The west MTB continued to have highly muted tidal exchange for most of the year. In addition, there are occasionally false alarms on the oil lease holder's sensor that cause the west MTB gate to close, preventing any tidal exchange. That causes water to build up and eventually reduce the cover of pickleweed due to prolonged immersion.

In the early years following the creation of the MTBs, they were largely inundated, composed of pickleweed, open water, and mudflat, and until 2014 were rarely used by western snowy plover for nesting. These basins have steadily gained in use by plovers over the past eight years and are now produce the most snowy plover fledglings. The MTB cells also provided foraging habitat for juvenile least terns and plover chicks from NS2.

NTI and STI are well established, man-made islands surrounded by the muted tidal waters of Inner Bolsa Bay. The surfaces of the islands are dredge spoils with a developed boundary of intertidal or salt tolerant vegetation. Both sites have degraded considerably over time due to erosion. The Bolsa Chica Land Trust has secured a grant and contractor to engineer and permit a restoration project with CDFW to return these sites to their original configuration. STI is a regular breeding area for California least terns but is also used by plovers. NTI has been used primarily by elegant tern (*Thalasseus elegans*), royal tern (*Thalasseus maximus*), Caspian tern (*Hydroprogne caspia*), black skimmers (*Rynchops niger*), and occasionally by western snowy plovers (one in 2022). In 2022 the large terns and skimmers did not nest on NTI or STI.

NS1 is a large linear nesting area between Inner Bolsa Bay and the Full Tidal Basin that was built during the creation of the Full Tidal Basin. The surface is dredge spoil that forms a flat surface extending from the West Levee Road east toward the Full Tidal Basin. The shoreline of the nest site is under tidal influence. The northeastern shoreline is becoming more structured, with pickleweed and suaeda (*Suaeda* sp.) forming in the intertidal zone. Fences have been installed at both ends of the nest site to prevent the public from accessing the site and to limit the access of mammalian predators. The site has been highly vegetated in the years since its creation and has required extensive vegetation control. The vegetative growth is primarily the native perennial beach sand-verbena (*Abronia umbellata* var. *umbellata*), the native California everlasting (*Gnaphalium californicum*), and other invasive non-native plants.

NS2 and NS3 were also created as part of the Restoration within Cell 42 and Cell 14, respectively. NS2 is in the east MTB and NS3 is within the FFTB. These sites were built up with fill and covered with sand. Both nest sites require some weed control. Some chicks from NS2 forage on the site

while others more commonly are led from the site by the adult(s) by swimming across surrounding water and foraging in adjacent MTB cells. Chicks on NS3 tend to leave the site immediately after hatching to seek forage in the surrounding Seasonal Pond cells. NS3 has a 6-foot-high chain link fence surrounding the entire nesting site.

Public access is not allowed on any of the nest sites. The human presence in the study area is mostly related to the operation of the oil field, consisting of large and small oil service vehicles and small work crews along the roads and well pads.

STUDY METHODS

NESTING SEASON PREPARATION

Following up on the 2021 recommendation to enhance nesting sites in 2022, 25 gravel pads were placed in Seasonal Pond cells and Future Full Tidal Basin cells. The pads were not of uniform size and ranged in size from 2x4 feet to 4x5 feet. A mixture of different sized gravel was used in each pad. In the Future Full Tidal Basin, single pads were placed in Cells 40 and 19, two pads in Cells 20 and 22, and three pads in Cells 19 and 21. In the Seasonal Ponds, two pads were placed in Cell 9, three in Cell 10, and four in Cells 11 and 12. Two of the 25 pads were placed under existing MEs, with the rest placed in open space.



Gravel nesting pads placed inside MEs and in open space.



Photo: P. Knapp

In the 2021/2022 non-breeding season MEs were left unoccupied to dissuade later coyote attention to MEs in the nesting season.

NESTING SURVEY

The principal survey effort for western snowy plover in 2022 was undertaken by California Department of Fish and Wildlife (CDFW) staff member, Peter Knapp, with assistance from Ross Griswold, a CDFW volunteer. Surveys were conducted daily by one or more individuals beginning in mid-February and continued until mid-September. Each nest and brood was checked daily, and sometimes twice daily, from a distance.

The accessibility and size of each nesting site dictated survey methods. STI and NS1 were surveyed by vehicle from the West Levee Road prior to arrival of the California least terns and then on foot (NS1) once nesting was initiated. NTI is typically used primarily by nesting large terns and black skimmer, but is monitored for western snowy plover from the West Levee Road. NS2 was surveyed by vehicle from the East Levee Road using a spotting scope with occasional survey efforts occurring

on foot. NS3 was surveyed by vehicle from the north end of the site. The large majority of suitable western snowy plover nesting habitat in the Seasonal Ponds was visible from the road network. Therefore, the observer(s) would slowly drive along the roads that subdivide this area. Frequent stops were made to examine specific areas adjacent to the road with binoculars or spotting scope without exiting the vehicle.

During each survey for western snowy plovers, observers documented the location of any new nests. NS1, NS2, NS3, and STI were sectioned by markers, which formed a grid of squares that were 20 meters on a side, for consistent methodology across the four sites. Data recorded outside of these four sites was done by cell number or road name. Each plover nest located during survey efforts was mapped for ease of relocation on subsequent visits and a numbered ME was placed on the nest.

It was usually possible to follow the movements and determine the fate of chicks of each brood on all sites since there was dispersion over space and time sufficient to differentiate between broods. In a few cases, banded adults identified specific broods. Broods were observed daily. These regular brood observations were conducted to determine chick survival and fledgling production, as well as to detect movement between cells and use of specific cells for brood rearing.

Beginning in 2021, use of two remote trail cameras was introduced to the monitoring to gain greater insight on nests during nocturnal periods and in unobserved periods of day. In 2022, the effort was expanded to 15 cameras.

Calculations were made to estimate the minimum number of adults present at Bolsa Chica during the breeding season. This was calculated by taking the number of nests (calculated as 2 adults) during the nesting season and combining that with the number of broods (calculated as 1 adult) present at the same time. This was performed each day of the breeding season. This method of estimating adults, referred to in this document as the Estimated Minimum Number of Adults method, is more accurate than the range-wide surveys described below, and has been performed since 2012 at Bolsa Chica.

A range-wide Winter Window Survey was conducted at Bolsa Chica on January 17, 2022 to estimate the number of adults present, in accordance with the guidelines set out in the Snowy Plover Recovery Plan (U.S. Fish and Wildlife Service 2007). A range-wide Breeding Season Window Survey was conducted on May 24, 2022 to estimate the number of adults, also in accordance with the Snowy Plover Recovery Plan. While these methods of estimating the number of adults present are known to considerably underestimate the true number, the surveys are still conducted and presented because they are called for in the Recovery Plan.

The collected data on nest distribution were plotted on a map, nesting summary statistics assembled, and the overall fledge rate determined as fledglings per male. In the past, this report also presented the metric of fledglings per nest. This has been discontinued as fledglings per male is the metric used in the Recovery Plan and better expresses the reproductive success of the breeding population.

PROTECTION FROM PREDATORS

Once a nest was discovered, a welded-wire ME was anchored in place over the top of the nest and left in place until the eggs hatched. The MEs are 28 inches in width on all four sides and top, and 16 inches in height. These dimensions have proven effective in deterring predation by corvids, gulls, and coyotes (*Canis latrans*). ME's are anchored at each corner and mid-section of each side. They were used on all nests in 2022 except Nests 5, 50, 51, 53, 75, 81, 113, 114, and 115.

Observations were made of potential predators during the surveys. Predator management has been a necessary recovery action for the California least tern for decades. In places such as Bolsa Chica where snowy plovers nest in proximity to the least tern, predator management activities on behalf of one species benefit the other species. Predator management was not undertaken at Bolsa Chica in 2019 or 2020 but was initiated late in the 2021 breeding season on a limited basis. In 2022, limited predator management was performed by Wildlife Innovations with grants from the Bolsa Chica Land Trust and the U.S. Fish and Wildlife Service.

CRC has previously placed NIXALITE on oil wells and other structures that CDFW staff determined to be detrimental to plover breeding success. NIXALITE is a strip of porcupine-like plastic spikes installed to discourage avian predator perching. Predators did still perch on wells with NIXALITE on a limited basis. Since 2018, CRC has maintained an alternative deterrent called Bird Spiders on wells used by predators for perching. Bird Spiders are a radiating array of wires that bounce and sway in the wind, creating a visual distraction and physical barrier to perching. However, both the NIXALITE and bird spiders have been unsuccessful in deterring predators, primarily American kestrels and red-tailed hawks, from perching.

Beginning in 2018, spider-like devices constructed of cork and wire were placed on signs and posts to deter predators from perching on structures other than oil wells, and adjacent to nesting and foraging sites. These have proven very effective in preventing predators from perching on these objects and were used continuously in 2022.

Since 2021, pin wheels have been placed on preferred predator perches and remained effective for the entire breeding season.

Clay roof tiles have been placed on STI, NS1, NS2, and NS3 to provide shelter for young least tern and plover chicks. Adult plovers also used the tiles as an elevated platform for viewing chick movement over surrounding vegetation.

RESULTS AND DISCUSSION

In 2022, the first snowy plover nest was established on March 25. The last bird fledged on September 10. There was a total of 115 nests producing 110 fledglings for the season, reflecting an increase over the prior two years (Table 1).

The following sections discuss the details of the nesting season.

NUMBERS OF BREEDING MALE AND FEMALE SNOWY PLOVERS

The daily estimated minimum number of adults present at Bolsa Chica during the 2022 breeding season was 114 (Minimum Number of Adults Methodology) (Table 1), meeting the management goal of 70 adults in the breeding season, as identified in the Snowy Plover Recovery Plan (U.S. Fish and Wildlife Service 2007).

The maximum number of concurrently active nests is used to estimate the minimum number of breeding females. The maximum number of concurrently active broods added to nest numbers on each date is used to estimate the minimum number of breeding males. This method of estimating the number of adults has always provided a higher count than the Breeding Season Window Survey (discussed below). We believe the Minimum Number of Adults Methodology is the more effective method for determining the size of the breeding population. Because this method has only been employed since 2012, only eleven years of data are presented in Table 1.

Table 1. Males and Females Based on Estimated Minimum Number of Adult Method, Nests, and Fledgling Production per Male 2012-2022.

Year	Females	Males	Total Adults	Total Nests	Fledglings	FI/Male
2022	44	70	114	115	110	1.57
2021	28	38	66	82	48	1.26
2020	48	64	112	110	43	0.67
2019	43	66	109	119	112	1.70
2018	55	66	121	115	115	1.74
2017	51	63	114	127	152	2.41
2016	38	58	96	99	145	2.50
2015	31	45	76	92	129	2.87
2014	31	48	79	82	113	2.35
2013	26	28	54	66	37	1.32
2012	28	35	63	68	77	2.20

The range-wide Winter Window Survey conducted on January 17, 2022 to estimate the winter population size found 28 adults. The range-wide, Breeding Season Window Survey conducted on May 24 resulted in a count of 72 adult snowy plovers (28 females, 37 males, and 7 unknown sex) at the Reserve (Table 2). The Breeding Season Window Survey result was considerably lower than the result from the Minimum Number of Adults Methodology (114 versus 72), despite them being conducted on the same day. There is often a large disparity between the two methods, with the

Breeding Season Window Survey considerably underestimating the true number. The Breeding Season Window Survey count is presented in Table 2 for consistency with the Recovery Plan.

Table 2. Males, Females, and Adults Based on Breeding Window Survey 1997-2022.

Year	Females	Males	Total Adults
2022	28 (7 unknown)	37	72
2021	20 (22 unknown)	26	68
2020	50	80	130
2019	41	53	94
2018	52 (2 unknown)	70	124
2017	46	60	106
2016	29	60	89
2015	25	37	62
2014	20 (2 unknown)	40	62
2013	22	31	53
2012	26	31	57
2011	20 (1 unknown)	28	49
2010	22	23	45
2009	25	22	47
2008	22	28	50
2007	18	12	30
2006	27	35	62
2005	25	41	66
2004	25	20	45
2003	15	16	31
2002	19	20	39
2001	19	18	37
2000	15	16	31
1999	12	11	32
1998	11	16	27
1997	14	20	34

NEST SITE SELECTION AND DISTRIBUTION

Figure 2 presents the distribution of snowy plover nests in 2022. In earlier years, this report has used the term “Successful Nest” on Figure 2, to indicate which nests successfully fledged at least one chick. We no longer use that term, because the eventual fledging or failure to fledge is less related to the location of the nest and more to conditions and events in the areas to which the parents take the brood to forage. Figure 2 now indicates only if the nest hatched at least one egg (marked green), or if it failed due to predation or abandonment (marked red). The nest of chicks

that were found only as broods were plotted in the cell in which the chicks were found; the actual location of the nest is not known.

Twenty of the 115 nests were placed in gravel substrate. Eight of the 25 placed gravel pads were used in 2022, with two of the eight being used twice. Neither of the pads placed under MEs were used.

In 2022, snowy plovers utilized all available nest sites typically used at Bolsa Chica except South Tern Island (Figure 2). The Seasonal Ponds had a similar number of nests (41, or 37% of all nests), but produced only 27 or 25% of all fledglings. Cell 10 in the Seasonal Ponds rebounded from a poor 2021, with 16 nests and 18 fledglings in 2022. The Muted Tidal Basin had 35% of all nests and produced 61% of the total fledglings, with Cell 46 producing the highest number of fledglings of any cell: 22 fledglings. The growing importance of the Muted Tidal Basin area to snowy plover is noteworthy. Figure 3 presents the considerable productivity of this area, which in recent years has supported many nests and produced the majority of fledglings.

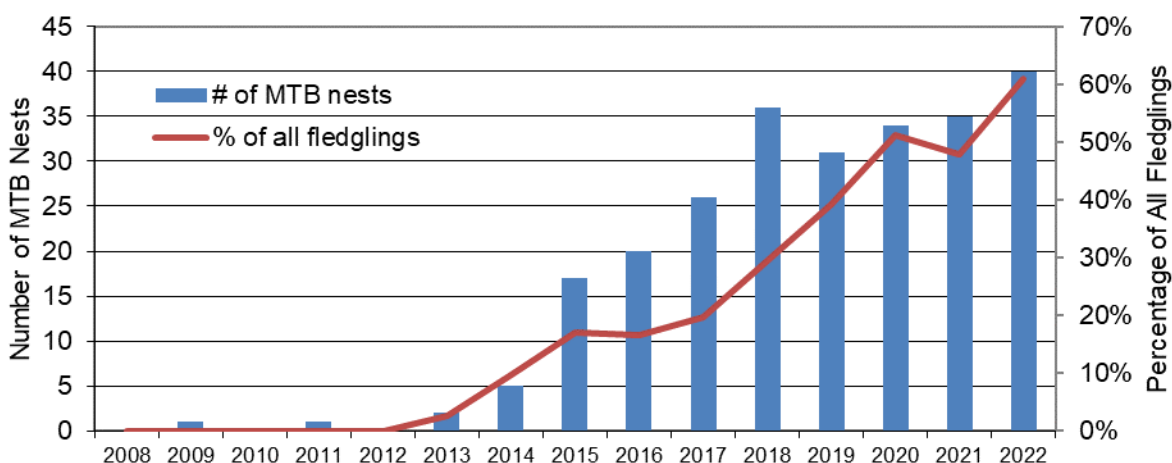


Figure 3. Western Snowy Plover Usage of the Muted Tidal Basin Post-restoration by Number of Nests and Percentage of Total Fledglings at Bolsa Chica.

The FFTB region has had inconsistent nesting success over the course of these studies. Since the Restoration was completed, the highest number of nests in the FFTB occurred in 2017 (29 nests), which was the same year that the Reserve reached its high point of 127 nests. In 2022 the total number of nests in the FFTB matched the 2017 total of 29 nests.

The man-made nest sites created during the Restoration (NS1, NS2, NS3) have declined in nesting numbers since the completion of restoration in 2006, after early adoption of these sites by plovers and least terns. The increase in vegetation and the limited carrying capacity of each site for plovers influenced this decline. In 2022 there were 13 nests, an increase from 10 nests in 2021.

The State and Federal Endangered California least tern also nests at Bolsa Chica. Snowy plover egg laying typically begins prior to the arrival of least terns and their egg laying. The two species tolerate the co-location of their nests, with both nesting on NS1, NS2, and NS3 in 2022. Only terns nested on STI and only plovers nested on NTI in 2022.

In 2022 large terns and skimmers did not attempt to nest on NTI; in 2021 they attempted but were unsuccessful for unknown reasons.

Table 3 presents the nesting information by location for 2022. The table also reports the number of fledglings by cell, though it should be noted that the fledglings may or may not have hatched from nests in that same cell. The broods frequently move from cells that were suitable for nesting into cells that provide suitable foraging space.

Table 3. 2022 Nests, Nest Fates, Chicks, and Fledglings by Location.

Location	Total Nests	Nests Failed no eggs hatched	Nests Hatched (# of chicks)	Fledglings
Seasonal Ponds	41	5	36 (98)	27
Cell 9	10	0	10 (26)	7
Cell 10	16	4	12 (33)	18
Cell 11	8	1	7 (21)	0
Cell 12	4	0	4 (10)	1
Cell 13	3	0	3 (8)	1
Nest Site 1	7	1	6 (16)	2
Nest Site 2	5	0	5 (13)	4
Nest Site 3	1	1	0	0
North Tern Island	1	0	1 (3)	1
Future Full Tidal Basin	20	2	18 (49)	9
Cell 14	4	1	3 (7)	2
Cell 19	4	0	4 (12)	0
Cell 22	2	1	1 (3)	1
Cell 25	1	0	1 (3)	0
Cell 30	1	0	1 (3)	1
Cell 32	2	0	2 (6)	1
Cell 33	1	0	1 (3)	0
Cell 35	1	0	1 (3)	0
Cell 40	4	0	4 (9)	4
Muted Tidal Basin	40	2	38 (104)	67
Cell 41	3	0	3 (8)	7
Cell 42	3	0	3 (6)	5
Cell 45	10	1	9 (22)	12
Cell 46	11	0	11 (32)	22
Cell 47	3	0	3 (9)	5
Cell 48	3	1	2 (6)	3
80 Road	7	0	7 (21)	13
Total	115	11	104 (283)	110

While not covered by this report, we note that western snowy plovers continued to nest on both Huntington (9 nests) and Bolsa Chica (1 nest) State Beaches in 2022.

Appendix 2 provides the cell location, start dates, nest fates, and eggs and chicks produced for each nest in 2022. Appendix 3 provides information on historical nest distribution.

NESTING

In 2022, the first plover nest was initiated on March 25, which was two weeks earlier than in 2021. The last nest hatched on August 13, and the last brood fledged on September 10. There was an active nest and/or brood for a total of 169 days of the 2022 breeding season at the Reserve. Nest chronology in 2022 is compared to the average of the prior 24 years at the Reserve in Figure 4, and to the average of 2014-2020, during which the recovery goal of breeding adults was met (per the Minimum Number of Adults Methodology). The breeding adult recovery goal was not met in 2021.

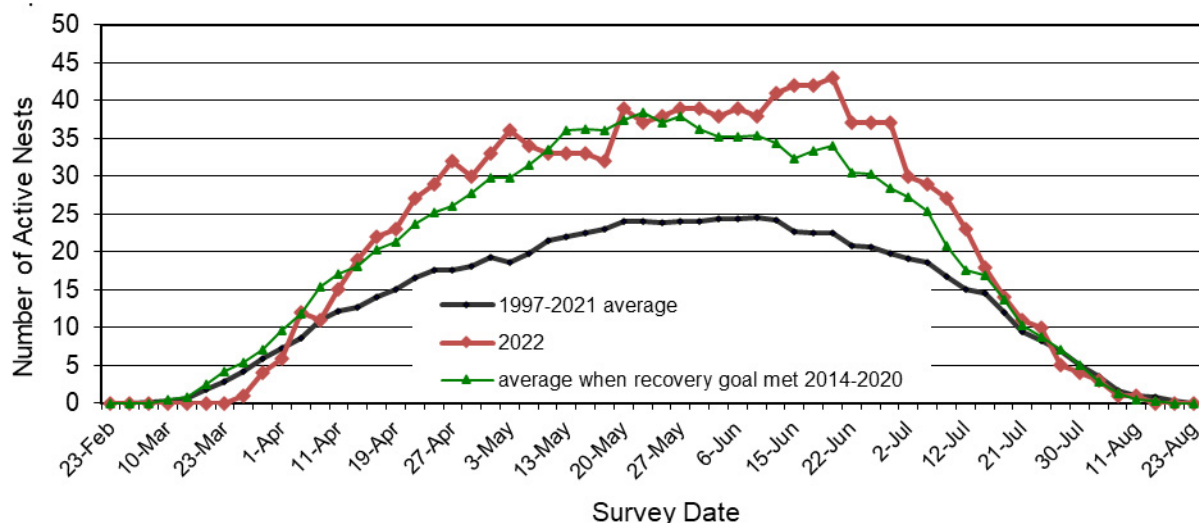


Figure 4. 2022 Western Snowy Plover Active Nest Chronology Compared to 1997-2021 Average and to Years When Breeding Adult Recovery Goal Was Met (2014-2020) at Bolsa Chica.

There was a total of 115 nests, with 104 nests hatching 283 chicks in 2022. Of the 115 nests only 61 nests fledged at least 1 chick.

EGGS, CHICKS, AND FLEDGLING PRODUCTION

A total of 329 snowy plover eggs were produced in 2022, with 283 hatching, all in the wild. There were two one-egg clutches, 12 two-egg clutches, and 101 three-egg clutches. Of the 46 eggs that did not hatch, 7 were predated and 39 failed to hatch and were recorded as Abandoned.

Of the 115 nests, five were found as a brood and the nest not specifically located, but were assigned to the cell where the broods were initially found. Of the remaining 110 nests, three nests were predated (detailed in the following section) and eight nests failed (no eggs hatched and recorded as Abandoned). The eight failed nests were: one that was incubated to hatch but didn't hatch, three that had one adult taken by a great horned owl and were subsequently abandoned by the other adult, and four abandoned for unknown reasons. Details are provided in Appendix 1.

Table 4 presents the number of nests, eggs, chicks, and fledglings produced at Bolsa Chica over the past 26 years of monitoring.

Table 4. Nests, Eggs, Hatch Success, and Fledgling Production 1997-2022.

Year	Nests	Eggs	Eggs Hatched	Eggs Failed to Hatch	Fledglings
2022	115	329	283	46	110
2021	82	214	174	40	48
2020	110	296	254	42	43
2019	119	321	283	38	112
2018	115	320	288	42	115
2017	127	361	340	21	152
2016	99	275	246	29	145
2015	92	244	208	35	129
2014	82	231	211	20	113
2013	66	185	140	45	37
2012	68	193	161	32	77
2011	73	207	164	43	62
2010	64	184	164	20	63
2009	70	201	184	16	42-70*
2008	67	193	174	19	57-109*
2007	50	143	130	13	25
2006	71	198	166	32	64
2005	51	153	115	28	75
2004	65	191	149	42	79
2003	32	92	76	16	44
2002	50	132	75	57	27
2001	55	156	63	93	57
2000	39	103	57	46	42
1999	38	102	71	31	23
1998	34	94	55	39	25
1997	30	79	44	35	ND

ND = not determined

* minimum/maximum number of fledglings

A total of 110 fledglings, produced from 70 breeding males, results in an overall fledge rate (fledglings/male) of 1.57 for 2022 (Table 1). The Population Viability Analysis for Pacific Coast Western Snowy Plover in Appendix D of the Recovery Plan used a model that suggests that productivity (fledge rate) of at least 1.0 fledglings per breeding male per year should result in a stable population. It goes on to report that productivity of 1.2 or more fledglings per breeding male should increase the population at a “moderate pace”. Figure 5 presents the overall fledge rate (fledglings per breeding male), based on the Estimated Minimum Number of Adults method, since 2012. It shows a fledge rate reflective of an increasing population in 2022.

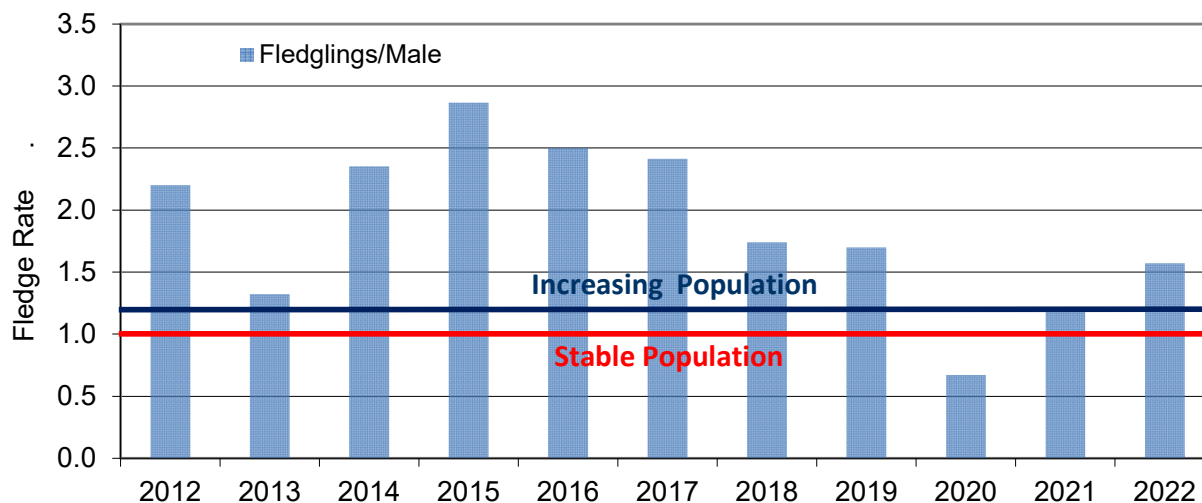


Figure 5. Western Snowy Plover Fledge Rate (Fledglings/Male) 2012-2022 at Bolsa Chica.

A total of 176 chicks failed to fledge in 2022. Of these, 24 died within the first day of hatching and 29 died on the second day (Figure 6). One hundred eight chicks (61%) died within the first week of hatching. These are clearly critical days in the survival of snowy plover chicks.

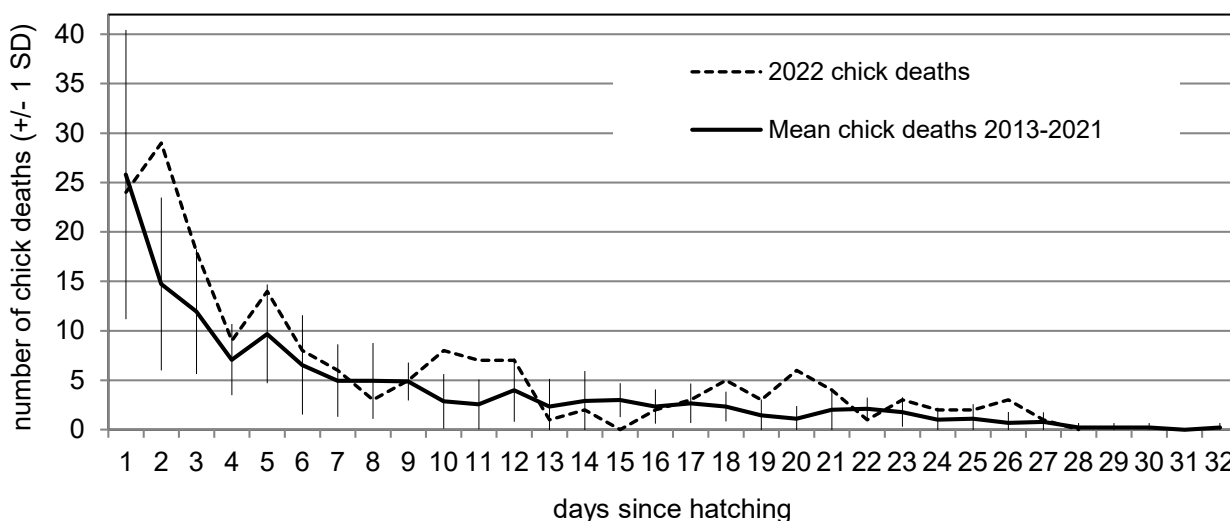


Figure 6. Number of Chick Deaths by Time since Hatching Compared to 2013-2021 Average at Bolsa Chica.

In past years there have been instances of prolonged incubation of one or more nests, resulting in failure to hatch. There was one instance of prolonged incubation in 2022 at Nest 81 in Cell 11.

Figure 7 presents graphically the fate of the nests, the eggs laid, and the chicks hatched. A nest fate labeled as “hatched” means that the nest hatched at least one egg.

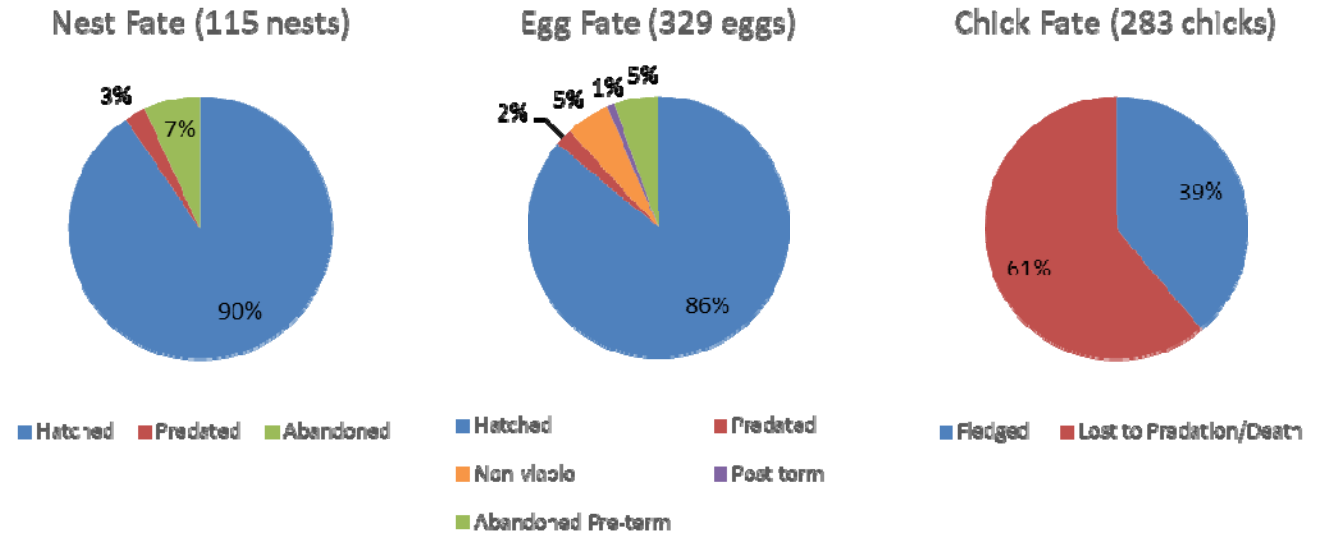


Figure 7. Fate of Nests, Eggs, and Chicks in 2022 at Bolsa Chica

All nest details are provided in Appendix 2.

PREDATION

In 2022 limited predator management was performed by Wildlife Innovations with funding from the Bolsa Chica Land Trust and the U.S. Fish and Wildlife Service.

Documented predation in 2022 included egg, chick, and adult predation. Three nests had eggs taken, each by a different species of predator: coyote, skunk, and ground squirrel. Two of the three predated nests were protected by an ME. Chick predation is thought to be the primary cause of mortality in chicks at Bolsa Chica. In 2022 chick mortality was significant, with the loss of 173 chicks. The take of two chicks in Cell 45 by a gull was witnessed by three individuals. This gull is believed to have taken additional chicks from this cell. Camera documentation of hatching chicks on NS1 confirmed the loss of three additional chicks to gulls. Ravens building a nest in Cell 19 are believed to have taken six chicks in Cell 19 upon their hatching. This accounts for a small percentage of documented chick loss, with the remainder believed to be primarily due to American kestrel that were present during the entire nesting season.

Adult plover predation was documented by cameras with the take of three adult plovers by a great horned owl. All three nests were protected by an ME. In each case, this predation event led to the subsequent abandonment of the nest by the surviving adult. The details of these events are provided in Appendix 1.



Predators recorded by trail cameras at snowy plover nests: coyote, American kestrel, raven, and great horned owl.

Table 5 compares the fate of nests based on whether they were protected by an ME. Only nine nests were unprotected by MEs, making comparisons difficult, but overall the protected nests successfully hatched chicks 92% of the time, compared to only 78% in nests not protected by MEs.

Table 5. Comparison of Nest Fates Based on Protection by MEs in 2022.

Fate	Protected by ME (106 nests)	Not protected by ME (9 nests)
Predated (count and % of total)	2 (2%)	1 (11%)
Abandoned (count and % of total)	7 (7%)	1 (11%)
Hatched (count and % of total)	97 (92%)	7 (78%)

EGG SALVAGE AND CHICK/ADULT RESCUES

A hatching egg and an unhatched egg from Nest 98, which had been abandoned after an adult had been taken by a great horned owl, were taken to the Wetlands and Wildlife Care Center but neither survived. A hatching egg and an unhatched egg from Nest 71 were taken to the Wetlands and Wildlife Care Center but both were under-developed and perished shortly after arriving the Center.

No chicks or adults were rescued in 2022.

TRAIL CAMERA USAGE

In 2022, additional cameras were procured and used extensively. A total of 42 photo folders, one for each nest monitored, were collected: 36 folders for plover nests and the other six were used for California least tern nests. The primary goal for the use of cameras was to document causes of nest abandonment. This was successful in that the great horned owl was identified as a lethal predator on snowy plover adults. Secondly the goal of identifying other species that could impact plover breeding success was achieved. The most frequent species captured in 20 of the nest folders was the coyote. In none of these instances did the coyote attempt to take eggs or adults. Corvids were seen at six of the nests early in the season. In addition to the three great horned owl takes of plover adults, they were seen at three other nests. Gulls were seen at two of the nests. Both a skunk and American kestrels, one inside a ME, were seen at one nest. The details of the losses documented by the trail cameras are provided in Appendix 1.

This new evidence about nest fate is valuable information that will inform plover management decisions at the Reserve. Camera use will be continued in 2023.

BROOD TRACKING

Due to the chronological and geographic spacing of each brood, it is usually possible to locate and identify individual broods over the period before they fledged, and it is these observations that are the basis for determining fledgling success. Movement within some cells can be considerable, with larger cells such as Cell 10 and Cell 11 making up approximately 17 and 54 acres, respectively.

As generally seen in prior years, in 2022 each brood tended to stay together, and the males prevented overlap or co-mingling with other broods. There were confrontations between the males if the broods wandered too close to each other or tried to take advantage of the same resources. Snowy plovers readily used the roads of Bolsa Chica to cover distances of 1/3 to 3/4 mile. In the Seasonal Ponds, broods would move about or change cells but could be identified. More than one cell may be

used by a brood, and often a brood would travel to another cell within one or two days of hatching. Broods from NS2 often left the site to forage in Cell 45 and movement within the Muted Tidal Basin was common. It is believed that NS2 will only support two or three broods at a time. This ability to disburse from the nest site to an adjacent cell probably contributes to fledgling successes at NS2.

OBSERVATIONS OF BANDED ADULTS

Four banded plovers nested at Bolsa Chica in 2022. They were: Gb:ak on Nest 37 (one of the oiled plovers from the October 2021 Pipeline P00547 Huntington Beach Oil Spill, see cover photo), Kp:by on Nest 88, nw:pl on Nest 90, and w:s on an unknown nest. This bird nested twice at Bolsa Chica in 2021. Other banded snowy plovers sighted at least once during 2022 are listed in Table 6.

It is worth providing details on one plover: yn:oy. In 2018, three salvaged eggs from an abandoned nest at Bolsa Chica Ecological Reserve were taken to the Wetlands and Wildlife Care Center in Huntington Beach where they were incubated to hatch and successfully raised to fledge age. They were banded and subsequently released at the Reserve. One of the three plovers was banded yn:oy, a female. She was seen at Camp Pendleton in July of 2018 and the next sightings of her were in 2019 at Huntington State Beach. She has nested and wintered at Huntington State Beach ever since. The October 2021 Pipeline Oil Spill affected Huntington State Beach and yn:oy was oiled. She was captured and cleansed of oil, but upon release again became oiled and required recapture and cleaning. She was successfully released and had 3 nests at Huntington State Beach in 2022.



Western snowy plover yn:oy Photo by Andrea Carpio



Plover chick Nn:gg
Photo by Brian Daniels

Interestingly, two of her banded offspring were seen this year at the Reserve: Nn:gg and Nn:ow. This unusual success story is due to her remarkable survival of the oil spill and is a positive example of salvaged eggs leading to successful entry into the breeding population of plovers. This is but one case of the successful addition to the breeding population.

Table 6. Banded Western Snowy Plovers Recorded at Bolsa Chica in 2022 Nesting Season.

Banding Location	Banding Year	Band	Notes	
Huntington State Beach	2022	Nn:gg	Yn:oy fledgling	
		Nn:ow	Yn:oy fledgling	
	2021	Gb:ak	nested at Bolsa Chica ER 2022, 2021 oiled bird	
		Gb:kb	2021 oiled bird	
		Gb:wk	2021 oiled bird	
		2021	Gb:kk	2021 oiled bird
		2022	Wp:gr	
	Unknown	wp:br		
Vandenberg	Unknown	nw:pl	nested at Bolsa Chica Ecological Reserve 2022	
Unidentified	Unknown	w:s	nested at Bolsa Chica Ecological Reserve 2022	
Camp Pendleton	2022	Lw:wb		
	2021	Ll:yp		
		Ll:yg		
	2020	Pp:rg		
	2019	Kp:yp		
		pw:bk		
2017	Kp:by	nested at Bolsa Chica Ecological Reserve 2022		
NAB Coronado	2021	Lg:kr		
		Kr:ya		
Zmudowski State Beach	2022	wo:bb		
Ormond Beach Oxnard	2022	py:ay	Ormond Beach eggs captive-reared at Santa Barbara Zoo and release at Coal Oil Preserve	
		py:yw		
Moss Landing	2019	Kr:ya		
Bolsa Chica Ecological Res	2018	yn:ro	nested at Bolsa Chica State Beach 2022	

MANAGEMENT RECOMMENDATIONS/ACTION ITEMS

Many recommendations from past years have been implemented with good results. These actions included: 1) placing tiles on the nest sites for the chicks to hide under, both providing protection from predation and a viewing platform for adults; 2) deploying MEs on nearly every snowy plover nest to reduce egg loss due to predation; and 3) continuing weed management on all manmade nest sites through manual removal of non-native plants and the use of herbicide. These management efforts have been effective in the enhancement of nest sites and improving reproductive success of the snowy plover and should continue. Additional management recommendations are provided below. The endangered California least tern, which nests in the same locations as the western snowy plover, needs to be considered in all management efforts. Ongoing and adaptive management actions are essential to improving western snowy plover reproductive success at Bolsa Chica.

1. Secure Means of Predator Management

The predator management in 2022 was provided by Wildlife Innovations and was focused on corvids and, later in the season, American kestrels. Corvid control was successful, while kestrel success was limited. By the time it was discovered that great horned owls presented a lethal threat to nesting plovers in 2022, funding for predator management was exhausted. For both the least tern and snowy plover, concentrated predator management for the full breeding season is required. The loss of 173 plover chicks was significant in that it represented the loss of 71% of chicks. In 2021, a similar 73% of chicks were lost.

Predator management is essential at Bolsa Chica. Funding is yet to be identified for 2023 predator control. A major expense of predator management is typically having a biologist documenting the reason for take or relation of a problem predator for each instance. Bolsa Chica is fortunate to have intensive and concentrated daily monitoring by Peter Knapp and Ross Griswold, who have firsthand knowledge of which individuals are responsible for the most predation, lightening the burden of long hours of additional investigation and documentation. It may be effective to have one predator control specialist as infrequently as every ten days to two weeks.

2. Protect snowy plover nests and chicks in the solution to Muted Tidal Basin dysfunction

The Muted Tidal Basin has been gaining in importance as nesting and foraging habitat for snowy plovers over the past 14 years (Figure 3). Nesting has expanded from 1 nest in the Muted Tidal Basin in 2009 to 36 nests in 2018, 31 nests in 2019, 34 nests in 2020, and to 35 nests in 2021 (Appendix 3). In 2022, 40 nests produced 67 fledglings. This region is critical to nesting plovers at Bolsa Chica, supporting 35% of all nests in 2022. Efforts are under way to remedy the hydrologic failures of the Full Tidal Basin/Muted Tidal Basin functionality, so that they will perform more closely to their designed hydrology. It is important that this exploration of options take into account likely impacts to plover nesting and foraging. Inundating these areas with even muted daily tidal flow would preclude nesting by most of those plovers.

3. Coyote “education”

Coyotes were an ever-present factor during both the breeding and non-breeding seasons at the Reserve. In the 2021/2022 non-breeding season the only attempt to dissuade coyote attention to MEs was to leave unoccupied MEs in place. These MEs will be left in place during the 2022/2023 non-breeding season. Remote cameras will be utilized to determine coyote interest. In 2022 cameras captured coyotes as the most frequent predator at a plover nest site, but no attempts to take were found on camera. There was one predation event where a coyote did take eggs from a nest poorly protected by a ME. There was not a camera on that nest.

It is recommended that these efforts be continued, with some winter MEs monitored with remote cameras.

4. Improve water management in the Seasonal Ponds

The Seasonal Ponds are an extremely important foraging and nesting area for the snowy plover. Based upon the recent history of early nest initiations and the fledgling success from those nests, it would appear advantageous to have areas within the Seasonal Ponds managed to support earlier nesting. It is important to have a flexible management process for balancing the amount of water in the Seasonal Ponds to make them available for snowy plover nesting and foraging.

Although culvert repairs and the Freeman Creek pump have improved the drainage of water from the Seasonal Ponds after inundation, they are not enough to drain key cells sufficiently for optimal plover nesting and brood rearing. The additional removal of water must be done with a portable pump, which requires a pit be present for the pump intake to be placed in. It has been previously recommended that pits be dug to facilitate the removal of ponded water in key cells in fall months, particularly in priority Cells 9, 10, 11, and 14.

Since at least the 2012 nesting season, apparent increases in the freshwater levels in Cell 11 promoted unusual freshwater marsh vegetation growth. One method to control this growth is provided for in the Bolsa Chica Lowlands Water Management Plan: Seasonal Ponds and Freeman Creek Water Management Unit (M&A 2012). This calls for the introduction of salt water into the Seasonal Ponds beginning immediately after the close of the breeding season. This has been done annually in September. This has been effective in stopping the spread of freshwater. It is recommended that this practice continue annually.

5. Enhance potential nesting areas

Following up on the 2021 recommendation to enhance nesting sites in 2022, 25 gravel pads were placed in Seasonal Ponds and the Future Full Tidal Basin. Based upon the use of gravel by plovers in 2022 and prior years, additional pads will be placed during the winter months for potential 2023 nesting. Some pads will be placed in the Muted Tidal Basin. The recommendation is to continue the enhancement of these areas each year and expand the method to other areas as deemed appropriate by the substrate present.

6. Continue monitoring

One of the key factors in the increasing success of nesting western snowy plovers at Bolsa Chica appears to be the intense monitoring and management employed to protect and track the nesting birds. It is recommended that monitoring continue annually with the same intensity to maintain the progress the plovers have made at Bolsa Chica, as the species attempts recovery range-wide.

7. Discourage predator perching in wetlands

Continue experimenting with techniques to discourage or eliminate perching and perches by predators in the wetlands. Beginning in 2021 two potential solutions to reduce available perches for predators were tried. The first was the use of flash tape which was successful, but due to windy conditions at Bolsa Chica only lasted for short periods. The second, assisted by the winds, was the placement of pin wheels on signage, normally favored perches by kestrels and hawks. These will be continued in 2023.

8. Expand use of remote cameras

The use of remote cameras to monitor snowy plover nests in 2022 was successful. Twenty cameras were available at the end of the 2022 season and it is not expected more will be needed to meet current contemplated monitoring plans.

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Appendix 1. Field notes by Peter Knapp, 2022.

FIELD NOTES

by Western Snowy Plover monitor Peter Knapp, 2022

NEST FAILURE ANALYSIS

There was a total of 11 nests that failed to hatch in 2022: three were predated and eight were abandoned (some after an adult was predated). The following describes the specific details of each failure.

Snowy plover Nest 2

This nest was discovered on 3/30/22 with one egg in Cell 10 on newly placed gravel with a ME immediately placed over the nest. On 4/1 a second egg was identified in the nest. On 4/2 a trail camera was installed. An incubating plover was seen beginning 4/3 through 4/6. On 4/7 and 8 there was no sighting of an incubating plover. On 4/9 the eggs were turned up in order to determine if incubation was being performed. The eggs remained turned up thru 4/11 at which time the nest was determined abandoned. There was no evidence of nest disturbance at any time.

The camera results follow. A total of eleven 20-second videos were recorded. Corvids were photographed in frames 3-5 on 4/4, and again in frames 8-11 on 4/8. On 4/8 two coyotes were also recorded. Plovers did not appear in any of the videos. The cause of the abandonment is unknown.

Snowy plover Nest 98

This nest was discovered as a 3-egg clutch on 6/26 in Cell 14. A plover was seen incubating each day thru 7/10. On 7/12 there was no incubation and the eggs were turned up. No further incubation was seen and the nest determined abandoned as the clutch remained intact.

This nest had a camera placed on it on 6/26. There was a total of 297 videos recorded thru 7/13. Upon examination of the camera results it was discovered that on 7/2 in frame #110, a great horned owl took an adult plover. What was unusual after the take of an adult is that the mate continued to incubate the egg thru 7/10 and in frame 284 on 7/14 at night a plover appeared around the ME but not inside.

The camera provided documentation that the cause of abandonment was the predation of one of the adults. What was unusual is that the mate incubated the nest for seven days after the take of the other adult. Further after abandonment one of the eggs hatched and the chick was found dead next to the nest and when discovered a second egg was hatching. Both the hatching egg and third egg were taken to the Wetlands and Wildlife Care Center but neither survived.

Snowy plover Nest 71

On 5/26 a two egg clutch was discovered on Nest Site 3. Incubation was not checked daily as was normal in most all other cases. A camera was placed on the nest on 6/3 and remained until 6/30. The nest was checked at least once a week during the least tern survey and the clutch of 3 eggs remained intact. On 6/25 the nest was examined, and a dead chick was found just outside of the scrape and as this was discovered the second egg was hatching. This hatching egg and the unhatched egg were taken to the Wetlands and Wildlife Care Center but both were under developed and perished shortly after receipt by the Center.

Upon examination of the camera there were 124 frames and in frame 13 on 6/9 it was discovered that a great horned owl had taken an adult plover. Again as was the case with Nest 98 it appears that the

mate attended the nest thru 6/21. Not associated with the take by the owl, in frames 35-40, two American kestrels were present with one inside the ME. Again the camera has provided documentation that the cause of abandonment was the take of an adult by a great horned owl.

Snowy plover Nest 82

This nest in Cell 45 was discovered on 6/12 as a complete 3-egg clutch. A camera was placed on the nest on the same day and remained thru 6/26. The camera recorded 336 videos. Incubation was seen thru 6/22. After 2 days when there was no indication that the nest was being incubated, the eggs were turned up. They remained up thru 6/25 indicating the nest had been abandoned. The camera was collected and upon examination of the camera recordings it was discovered that on 6/19 in frame 232 a great horned owl took an adult plover. This was the first knowledge that a take of one of the adults had occurred. The mate of the predated plover continued incubation for 3 days after the loss of the mate.

The four nests above had cameras whereas the other 4 nests that were classified as abandoned did not have cameras. The undocumented nests were Nests 15 and 29 in Cell 10, Nest 12 in Cell 22 and Nest 81 in Cell 11. The latter was incubated post term for 45 days and was the only abandoned nest without a ME. The cause of the abandonment of Nests 2, 12, 15 and 29 is unknown.

There were three nests predated. Nest 5 in Cell 10 was predated by either squirrels or corvids, both of which were seen in the immediate area at the time of loss. The nest did not have a ME. Nest 34 in Cell 48 with a ME in place was taken by a coyote. The ME was located on a berm at the side of a road and was not anchored on a level surface that facilitated the take. Nest 49 on NS1 with a ME was taken by a skunk.

Appendix 2. Snowy plover nests, eggs laid, nest fate, chicks hatched, and fledged at Bolsa Chica, 2022

Nest #	Date Found	Date Ended	Cell/Location	Grid#	# Eggs	Nest Fate	# Chicks	# Fledged	Bands	Substrate/Comments
1	28-Mar-22	28-Apr-22	9		2	H	2	1		Gravel New Cam 4/23-4/29
2	30-Mar-22	7-Apr-22	10		2	2A	0	0		Gravel New Cam 4/2-4/11
3	30-Mar-22	30-Apr-22	12		3	1A/2H	2	0		Shells Cam 4/11-5/1
4	31-Mar-22	28-Apr-22	47		3	H	3	1		Salt panne Cam 4/2-4/28
5	3-Apr-22	11-Apr-22	10		2	2P	0	0		Pickleweed, No ME
6	4-Apr-22	7-May-22	19		3	H	3	0		Dry AI
7	5-Apr-22	1-May-22	32		3	H	3	1		Salt panne
8	8-Apr-22	1-May-22	47		3	H	3	3		Gravel Old Cam 4/29-5/1
9	5-Feb-22	11-May-22	80Rd		3	H	3	3		Gravel, Old
10	10-Apr-22	11-May-22	80Rd		3	H	3	3		Gravel, Old
11	11-Apr-22	6-May-22	45		2	H	2	2		Salt panne, cam 4/11-5/6
12	13-Apr-22	27-Apr-22	22		3	3A	0	0		Salt panne
13	14-Apr-22	12-May-22	46		3	H	3	3		Salt panne
14	15-Apr-22	12-May-22	NS1	31B	3	1A/2H	2	2		Salt panne
15	16-Apr-22	4-May-22	10		2	2A	0	0		Salt panne
16	16-Apr-22	22-May-22	12		3	H	3	0		Salt panne
17	17-Apr-22	13-May-22	9		3	H	3	2		Salt panne
18	17-Apr-22	15-May-22	80Rd		3	H	3	3		Gravel
19	18-Apr-22	15-May-22	40		3	1A/2H	2	1		Salt panne
20	19-Apr-22	18-May-22	9		3	2A/1H	1	0		Salt panne Middle pickleweed plant
21	19-Apr-22	16-May-22	46		3	H	3	1		Salt panne Cam 6/5-5/17
22	20-Apr-22	22-May-22	80Rd		3	H	3	2		Gravel
23	20-Apr-22	23-May-22	19		3	H	3	0		Gravel, New
24	20-Apr-22	17-May-22	13		3	1A/2H	2	0		Salt panne, Cam 4/20-5/17
25	21-Apr-22	18-May-22	48		3	H	3	2		Salt panne, Well pad
26	22-Apr-22	20-May-22	10		3	H	3	3		Salt panne
27	24-Apr-22	24-May-22	9		3	H	3	1		Salt panne/Old shells Cam 4/24-5/31
28	26-Apr-22	28-May-22	35		3	H	3	0		Salt panne/Old sandbag
29	27-Apr-22	31-May-22	10		3	3A	0	0		Gravel New
30	29-Apr-22	3-Jan-22	NTI		3	H	3	1		Salt panne
31	29-Apr-22	28-May-22	40		2	H	2	2		Rocks
32	30-Apr-22	26-May-22	10		3	H	3	3		Salt panne Under dead pickle weed. Cam 4/30-5-26
33	30-Apr-22	31-May-22	11		3	H	3	0		Salt panne
34	2-May-22	7-May-22	48		2	2P	0	0		Salt panne, Coyote predation of eggs
35	2-May-22	31-May-22	46		3	1A/2H	2	2		Salt panne

Western Snowy Plover Nesting at Bolsa Chica, 2022

Nest #	Date Found	Date Ended	Cell/Location	Grid#	# Eggs	Nest Fate	# Chicks	# Fledged	Bands	Comments
36	3-May-22	4-Jun-22	12		3	H	3	1		Salt panne/Gravel Cam 5/10-6/4
37	3-May-22	28-May-22	48		3	H	3	1	Gb:wk	Salt panne
38	4-May-22	1-Jun-22	NS2		3	H	3	1		Salt panne/Sand Cam 5/4-6/4
39	5-May-22	31-May-22	11		3	H	3	0		Salt panne, Very wet in area of nest
40	6-May-22	4-Jun-22	46		3	H	3	3		Salt panne/Gravel Well pad
41	10-May-22	26-May-22	25/26		3	H	3	0		Gravel Middle of road
42	13-May-22	14-Jun-22	41		3	H	3	3		Salt panne
43	13-May-22	14-Jun-22	30		3	H	3	1		Salt panne
44	13-May-22	2-Jun-22	NS1	2A	3	H	3	0		Sand
45	13-May-22	12-Jun-22	9		3	H	3	0		Salt panne
46	13-May-22	14-Jun-22	10		3	H	3	2		Gravel New same as nest #2 Cam 5/13-6/17
47	15-May-22	9-Jun-22	40		3	H	3	0		Gravel New. Cam 5/17-6/9
48	16-May-22	16-Jun-22	32		3	H	3	0		Salt panne
49	16-May-22	7-Jun-22	NS1	33A	3	3P	0	0		Salt panne /Sand
50	15-May-22	15-May-22	45		1	H	1	1		Unknown Found as brood of 1. No ME
51	17-May-22	11-Jun-22	46		3	H	3	3		Salt panne
52	17-May-22	8-Jun-22	13		3	H	3	0		Salt panne
53	18-May-22	18-May-22	33		3	H	3	0		Unknown Found as brood of 3. No ME
54	19-May-22	17-Jun-22	NS1	31A	3	H	3	0		Salt panne /Sand Cam 6/8-6/18
55	20-May-22	18-Jun-22	80 Rd		3	H	3	0		Gravel
56	21-May-22	21-Jun-22	22		3	H	3	1		Salt panne Same as nest #12 Cam 5/21-6/22
57	23-May-22	20-Jun-22	9		3	1A/2H	2	1		Gravel New Same as nest#1 Cam 5/23-6-24
58	23-May-22	20-Jun-22	10		3	1A/2H	2	2		Salt panne
59	25-May-22	19-Jun-22	10		3	1A/2H	3	1		Salt panne Same as # 15
60	26-May-22	21-Jun-22	NS2	Shore	3	H	3	0		Salt panne
61	27-May-22	21-Jun-22	11		3	H	3	0		Salt panne Cam 5/27-6-21
62	27-May-22	7-Jun-22	10		3	H	3	1		Salt panne
63	28-May-22	29-Jun-22	42		3	H	2	1		Gravel, Previously used
64	28-May-22	21-Jun-22	46		3	H	3	3		Salt panne
65	27-May-22	25-Jun-22	46		3	H	3	2		Salt panne, Previously used this year under ME
66	29-May-22	15-Jun-22	10		3	H	3	0		Salt panne
67	31-May-22	28-Jun-22	10		3	H	3	2		Salt panne
68	28-May-22	20-Jun-22	9		3	H	3	1		Salt panne
69	31-May-22	17-Jun-22	46		3	H	3	2		Salt panne
70	26-May-22	26-Jun-22	NS2	2D	3	H	3	3		Salt panne
71	26-May-22	30-Jun-22	NS3		3	3A	0	0		Salt panne Cam 6/3-6-30. GHOW predation of adult
72	3-Jun-22	3-Jul-22	11		3	H	3	0		Salt panne
73	4-Jun-22	4-Jul-22	NS1	28A	3	H	3	0		Salt panne Cam 6/4-74
74	5-Jun-22	28-Jun-22	11		3	H	3	0		Salt panne Cam 6/5-73
75	5-Jun-22	2-Jul-22	46		3	H	3	2		Salt panne

Western Snowy Plover Nesting at Bolsa Chica, 2022

Nest #	Date Found	Date Ended	Cell/Locator	Grid#	# Eggs	Nest Fate	# Chicks	# Fledged	Bands	Comments	
76	7-Jun-22	1-Jul-22	10		3	H	3	1		Salt panne	
77	8-Jun-22	1-Jul-22	41		2	H	2	2		Salt panne, AMAV old nest	
78	11-Jun-22	7-Jul-22	45		3	H	3	3		Salt panne	
79	11-Jun-22	30-Jun-22	45		3	H	3	0		Salt panne	
80	12-Jun-22	29-Jun-22	13		3	H	3	1		Salt panne	
81	12-Jun-22	7-Aug-22	11		2	2A	0	0		Salt panne	
82	12-Jun-22	26-Jun-22	45		3	3A	0	0		Salt panne Cam 6/12-6/26	
83	12-Jun-22	10-Jul-22	45		3	H	3	0		Salt panne	
84	13-Jun-22	13-Jul-22	NS1	36B	3	1A/2H	2	0		Salt panne Cam 6/24-7/14	
85	14-Jun-22	7-Jul-22	45		3	H	3	3		Salt panne	
86	14-Jun-22	24-Jun-22	12		3	1A/2H	2	0		Gravel New	
87	16-Jun-22	10-Jul-22	42		3	2A/1H	1	1		Salt panne Cam 6/22-7/17	
88	17-Jun-22	16-Jul-22	45		2	H	2	0	Kp:by	Salt panne Cam 6/22-7/21	
89	16-Jun-22	10-Jul-22	80 Rd.		3	H	3	0		Gravel	
90	18-Jun-22	13-Jul-22	10		3	H	3	1		Salt panne	
91	19-Jun-22	12-Jul-22	46		3	H	3	0		Salt panne	
92	19-Jun-22	14-Jul-22	46		3	H	3	1		Salt panne	
93	22-Jun-22	14-Jul-22	14		3	H	3	2		Salt panne Cam 6/22-7/15	
94	22-Jun-22	17-Jul-22	42		3	H	3	3		Salt panne Cam 6/22-7/21	
95	22-Jun-22	17-Jul-22	41		3	H	3	2		Salt panne	
96	17-Jun-22	17-Jul-22	NS2		3	H	3	0		Salt panne	
97	25-Jun-22	19-Jul-22	47		3	H	3	1		Salt panne Cam 6/25-7/21	
98	26-Jun-22	13-Jul-22	14		3	3A	0	0		Salt panne Cam 6/26-7/17 GHOW predation of adult	
99	26-Jun-22	26-Jul-22	9		3	H	3	0		Salt panne Cam 6/26-7/27	
100	28-Jun-22	25-Jul-22	80 Rd.		3	H	3	3		Gravel	
101	29-Jun-22	27-Jul-22	14		2	H	2	0		Gravel Cam 6/30-7/29	
102	29-Jun-22	12-Jul-22	9		3	H	3	0		Salt panne	
103	30-Jun-22	11-Jul-22	NS1	29C	3	H	3	0		Salt panne/Sand Cam 6/30-7/12	
104	2-Jul-22	26-Jul-22	45		3	H	3	2		Salt panne	
105	3-Jul-22	20-Jul-22	19		3	H	3	0		Salt panne Cam 7/4-7/20	
106	3-Jul-22	27-Jul-22	14		2	H	2	0		Salt panne Cam 7/1-7/27	
107	3-Jul-22	27-Jul-22	11		3	H	3	0		Salt panne Cam 7/24-7/27	
108	6-Jul-22	4-Aug-22	10		2	1A/1H	1	0		Salt panne Cam 7/23-8/5	
109	6-Jul-22	22-Jul-22	19		3	H	3	0		Gravel New	
110	7-Jul-22	20-Jul-22	9		3	H	3	1		Salt panne	
111	9-Jul-22	28-Jul-22	45		3	1A/2H	2	1		Salt panne Cam 7/23-7/29	
112	12-Jul-22	11-Aug-22	40		2	H	2	1		Salt panne	
113	16-Jul-22	16-Jul-22	11		3	H	3	0		Salt panne Found as brood of 3. No. ME	
114	16-Jul-22	16-Jul-22	10		3	H	3	1		Salt panne Found as brood of 3. No ME	
115	17-Jul-22	15-Aug-22	NS2	Slope	3	2A/1H	1	0		Salt panne No ME	
TOTALS					329	39A/7P	283	110			

Appendix 3. Distribution of Western Snowy Plover Nests at Bolsa Chica for 1997 through 2022.

Number of nests by area at Bolsa Chica

Year	Total # Nests	Cells eliminated during restoration	Seasonal Ponds	FFTB	MTB	NTI	NS1	NS2	NS3	STI	Other
1997	31	14	11	4						2	
1998	34	16	15	2						1	
1999	38	14	11	11						2	
2000	39	11	21	6						1	
2001	55	19	29	5						2	
2002	50	14	17	19							
2003	32	11	9	3						9	
2004	65	17	33	10						5	
2005	51	6	30	8						7	
2006	71	13	13	16			16	1	8	4	
2007	50		10	9			19		8	4	
2008	67		10	10			37		5	4	1
2009	70		16	9	1	1	32	3	5	3	
2010	64		11	4		1	26	4	14	2	2
2011	73		19	7	1	1	12	13	16	3	1
2012	68		26	11			12	7	9		3
2013	66		28	5	2		16	4	8	1	2
2014	82		38	8	5		9	13	7	1	1
2015	92		41	8	17	1	9	8	5	3	
2016	99		46	12	20		7	3	9	2	
2017	127		55	29	26		3	5	8	1	
2018	115		40	21	36		7	7	2	1	
2019	119		49	17	31	1	6	7	3	1	4
2020	110		41	13	34		5	12	2	3	
2021	82		25	11	35		6	3	1	1	
2022	115		41	20	40	1	7	5	1		

Number of nests by cell at Bolsa Chica

Year	Cell 2	Cell 9	Cell 10	Cell 11	Cell 12	Cell 13	Cell 14	Cell 19	Cell 20	Cell 21	Cell 22/23	Cell 25	Cell 30	Cell 31	Cell 32	Cell 33	Cell 34	Cell 35	Cell 36	Cell 40	Cell 41	Cell 42	Cell 45	Cell 46	Cell 47	Cell 48.	Cell 50	80 Rd.
1997			4	7			1				2																	
1998		2	7	6			1				1																	
1999			6	5			1	5			4																	
2000		2	6	12	1		1				1									3								
2001	1	8	11	9				5																				
2002	1	2	1	10		3	3				10									1								
2003		6	1		2			1																				
2004		5	12	13	2	1	1	1			4		1															
2005	1	6	8	12	3		1	4								3												
2006			2	6	5						13				2	1												
2007			1	6		3		1			3				4		1											
2008		2	5		3			4			6																	
2009		2	6	2	5	1	2	2			3	1		1									1					
2010		2	5	3	1		3				1																	
2011		9	3	3	1	3	3	1			2				1								1					
2012		6	4	9	4	3	2	3			3		1		1						1							
2013		5	10	8	3	2	2	2			1										1			1				
2014		12	9	11	2	4	5	1			1		1										2	3				1
2015	1	8	15	10	5	2	4			2											2	2	3	5	1			5
2016	1	12	15	13	3		6				1											5	2	6	2	1		4
2017		12	21	16	2	4	6	3		1	2	1	2	1	3	2	2	1	0	2	8	5	9	3	0	1		1
2018	3	7	18	7	1	4	5	2		1	5	1		1	3	1	1		1	1	7	6	9	5	5	1		3
2019	2	13	18	8	4	4	5	1		1	1		2		3	2				2	11	4	6	7	3	3		1
2020	1	11	12	5	2	5	6	1			1					1				4	9	6	4	6	2	1	1	5
2021	2	4	5	9	3	1	2				5					1				1	3	4	5	5	3	2		8
2022		10	16	8	4	3	4	4			2	1	1		2	1			1	4	3	3	10	11	3	3		7

*This table does not include nesting on the manmade nest sites (NS1, NS2, NS3, NTI, and STI), refer to prior table for these data

Additionally:

2021- snowy plover nested on the road between Cells 13 and 22, Cells 11 and 12, on Rattlesnake Road (1), the 70 Road (2), and the 100 Road (1).

2020- snowy plover nested on the road between Cells 2 and 10, Cells 10 and 11.

2019- snowy plover nested on the 70 Road for the first time.