

California Least Tern
(*Sternula antillarum browni*)

5-Year Review:
Summary and Evaluation



Photo by Matt Sadowski

U.S. Fish and Wildlife Service
Carlsbad Fish and Wildlife Office
Carlsbad, California

August 2025

5-YEAR REVIEW

California least tern (*Sternula antillarum browni*)

GENERAL INFORMATION

Species: California least tern (*Sternula antillarum browni*), a bird subspecies

Date listed: The California least tern was federally listed on March 8, 1969, under the Endangered Species Preservation Act of 1966

Federal Register citation: Service 1969 (34 FR 5034)

Classification: Endangered (Service 1970, appendix A) (35 FR 8491)

Recovery Plan: Final, September 27, 1985. Revised California Least Tern Recovery Plan.

Recovery Priority Number: 15C is the current recovery priority number. See Conclusion section for recommended change to 12C.

Critical Habitat Designation: No critical habitat has been designated for this species.

BACKGROUND

Under the Endangered Species Act of 1973, as amended (Act; 16 U.S.C. 1531 et seq.), the U.S. Fish and Wildlife Service (Service), referred to as “we” in this document, maintain lists of endangered and threatened wildlife and plant species (referred to as the List) in the Code of Federal Regulations (CFR) at 50 CFR 17.11 (for wildlife) and 17.12 (for plants). Section 4(c)(2)(A) of the Act requires us to review each listed species’ status at least once every 5 years.

Most recent status review: Service. 2020. California least tern (*Sternula antillarum browni*) 5-year Review: Summary and Evaluation. Prepared by the Carlsbad Fish and Wildlife Office, Carlsbad, California. 94 pp. + appendices.

We initiated the previous status review for California least tern on June 18, 2018 (Service 2018, entire (83 FR 28251)). The review was finalized on July 9, 2020, and recommended no change in status.

Federal Register notice announcing this status review: On October 16, 2024, we published a *Federal Register* notice announcing initiation of the 5-year review of this species, and the opening of a 60-day period to receive information (Service 2024, entire).

Species Overview and Habitat: The California least tern is a subspecies of the least tern, a small, colonially nesting seabird. The California least tern nests along the Pacific coast of California, United States and the Baja California Peninsula, Mexico. The northernmost nesting locations are adjacent to San Francisco Bay, California, and the southernmost is near the tip of the Baja California Peninsula. Least tern nesting sites are established on open sandy beaches, salt flats within estuarine areas, and unvegetated dredge material islands and shorelines near rivers, bays, or lagoons.

ASSESSMENT

Information acquired since the last status review

This 5-year review was conducted by the Service's Carlsbad Fish and Wildlife Office. Data for this review were solicited from the public and interested parties through a *Federal Register* notice announcing this review on October 16, 2024. We also contacted Federal agencies, State agencies, and other interested parties to request any data or information we should consider in our review. Additionally, we conducted a literature search and reviewed information in our files.

SUMMARY OF NEW INFORMATION

The below subsections of this document summarize the new information available for California least tern taxonomy, distribution, abundance, reproduction, and life history. The subspecies taxonomy of the least tern remains a focus of scientific study; while some sources now recognize only three subspecies, we continue to recognize the California least tern subspecies as separate from least terns that breed in the Gulf of California and southwestern Mexico. Nesting area distribution, breeding pair abundance, and fledging ratios are presented for 2012–2023 in California and breeding pair abundance for 1991–2024 in Mexico. Based on California data (which encompasses most of the breeding population), the number of breeding pairs continues to decline while the number of fledglings may have stabilized over the past 6 years hovering at or just below approximately 1,000 fledglings per year (Figure 4, Table 5). However, compared to the information presented in the 2020 5-year review (2012–2017), both the number of breeding pairs and number of fledglings have declined.

Completed and ongoing research continue to fill in gaps about California least tern life history. A recent study using stable isotopes suggests that California least terns and least terns in the Gulf of California migrate south from nesting areas and spend most of their time feeding in the pelagic zone during the nonbreeding season (Morales Flores 2024, pp. 36–43). Banding and mark-recapture efforts have provided new information about reproductive life span, natal dispersal, and long-distance movements (Ryan and Heyne 2020, pp. 23, 25, 30–32; Robinette 2021, pp. 5–6; Ryan et al. 2025, pp. 3, 13). An ongoing Motus tracking study has also begun to provide new information on foraging movements within the breeding season (Vilchis 2025, pers comm.) and a nest camera study provided data on parental nest attendance (Robinette 2021, pp. 6–8). This 5-year review also summarizes new information about California least tern diet and foraging from another five studies (Fournier 2016, entire; Robinette 2021, entire; Leicht et al. 2023, entire; Mills 2024, entire; Morales Flores 2024, entire).

There are numerous partners that are actively engaged in the monitoring and management of the California least tern. Requirements for annual management to achieve successful recruitment of juveniles into the population demonstrate that this subspecies is conservation reliant, which means that it will likely continue to require management, even after population recovery is achieved. In response to the continued declining population trend, the Service and the Department of Defense finalized a California least tern Species Action Plan in 2024 (Service and DoD 2024, entire). The implementation of the steps outlined in the Species Action Plan are ongoing.

Subspecies Taxonomy

As explained in the 2020 5-year review, five subspecies of least tern (*Sternula antillarum*) have been described in the scientific literature based on subtle differences in morphological features (i.e., overall size; bill, leg, and wing lengths; and plumage coloration). The five subspecies are (1) *S. a. antillarum* (eastern least tern) that breeds along the Atlantic and Gulf Coasts, (2) *S. a. athalassos* (interior least tern) that breeds in interior United States, (3) *S. a. browni* (California least tern) that breeds along the Pacific Coast of California and the west coast of the Baja California Peninsula, (4) *S. a. mexicana/mexicanus* (no accepted common name, although Mexican least tern is sometimes used) that breeds along the Gulf of California coast of northern mainland Mexico and east coast of the Baja California Peninsula, and (5) *S. a. staebleri* (no accepted common name) that breeds along the Pacific Coast of southern mainland Mexico (Patten and Erickson 1996, pp. 888–890). However, many authors have questioned the distinctiveness of one or more subspecies of least tern (Willett 1933, p. 78; Burleigh and Lowery 1942, p. 175–177; Massey 1976, p. 768; Thompson et al. 1992, p. 259; Gochfeld and Burger 1996, p. 657; Patten and Erickson 1996, pp. 888–890; Palacios and Mellink 1996, p. 49; Massey 1998, p. 181; Draheim 2006, pp. 33, 74; Whittier et al. 2006, p. 182; Pyle 2008, p. 704; Draheim et al. 2010, pp. 807). Massey (1998, p. 181) questioned whether *S. a. browni* was distinguishable from the two other west Mexico subspecies *S. a. mexicana* and *S. a. staebleri*. Two genetic studies of least tern population structure included samples only from the United States (*S. a. browni*, *S. a. athalassos*, and *S. a. antillarum*) (Whittier et al. 2006, entire; Draheim et al. 2010, entire), which did not address potential distinctiveness between *S. a. browni* and its neighboring subspecies in Mexico. In recent studies, authors have combined all Pacific coast and Gulf of California subspecies into *S. a. browni* (e.g., Draheim et al. 2010, p. 808; Draheim et al. 2012, p. 147). However, this was done without any additional genetic or morphological studies of examples from Mexico, and further research was suggested (Patten and Erickson 1996, p. 889; Whittier et al. 2006, p. 182). Authoritative bird taxonomy lists currently recognize only three subspecies (*S. a. browni*, *S. a. athalassos*, and *S. a. antillarum*), merging all the Pacific coast and Gulf of California subspecies into *S. a. browni* (AviList 2025, unpaginated; Gill et al. 2025, unpaginated).

Given the equivocal information in the taxonomic literature, we have examined the available information on the movement of individual least terns between the ranges of the other subspecies. Our previous assessments of banding data have not revealed evidence of intermixed breeding between *Sternula antillarum browni* and other subspecies in Mexico (Service 2014, p. 14; Service 2020, p. 21). Since 2017 (Baja California Sur) and 2022 (Sonora and Sinaloa), more intensive efforts (including searches by trained observers, adult capture, and nest cameras) have failed to detect least terns banded in California at nesting colonies in southern Baja California, Baja California Sur, Sonora, or Sinaloa (Ryan et al. 2025, pp. 3, 13). These efforts have also demonstrated that nesting California least terns regularly move between nesting sites in southern California and nesting sites near Ensenada and San Quintin in Baja California, Mexico, all of which are in the known range of the California least tern (Ryan and Heyne 2020, p. 30). Thus far, no least tern from one subspecies region has been documented nesting in another subspecies region (Ryan et al. 2025, pp. 3, 13).

Preliminary analyses by Ryan, Palacios-Castro, Solana-Arellano, et al. (in prep.) indicate significant differences in outer and central tail length and the number of outer black primary feathers between adult least terns measured in the Gulf of California and the Pacific Coast (Table 1). This provides support for original descriptions made by Mearns (1916, p. 71), van Rossem and Hachisuka (1937, p. 334), and Brodkorb (1940, p. 542); *Sternula antillarum browni* has a smaller tail and more frequently has three outer black primary feathers compared to *S. a. mexicana* or *S. a. staebleri*. Genetic studies of mitochondrial DNA and microsatellites sampled from *S. a. browni* and *S. a. mexicana* are currently being conducted by L. Ortiz-Serrato at the Centro de Investigación Científica y de Educación Superior de Ensenada, Mexico.

Table 1. Regional differences in plumage of Least Terns (*Sternula antillarum*) from California and Northwest Mexico. Table provided by Ryan, Palacios-Castro, Solana-Arellano, et al. (in prep.).

Region	Variable	Number sampled	Mean	Standard deviation	Standard error	Difference	Confidence interval-low	Confidence interval-high	P value
Gulf of California	# Black outer primaries (0–3)	68	2.353	0.512	0.062	-0.215	-0.379	-0.051	0.011
Pacific Coast	# Black outer primaries (0–3)	81	2.568	0.498	0.055				
Gulf of California	Outer tail length	70	78.800	6.369	0.761	2.226	-0.020	4.473	0.052
Pacific Coast	Outer tail length	68	76.574	6.953	0.843				
Gulf of California	Center tail length	70	40.614	2.773	0.331	1.202	0.408	1.996	0.003
Pacific Coast	Center tail length	80	39.413	2.023	0.226				

While there have been several publications that question the distinctiveness of least tern subspecies, studies have mainly focused only on the three United States subspecies (California least tern, interior least tern, and eastern least tern); none have comprehensively examined the species throughout its range, nor examined populations in western Mexico where two other subspecies have been described. A taxonomy study is needed that distinguishes subspecies by integrating multiple lines of evidence, such as morphology, genetics, and movement ecology. It would be helpful for researchers to obtain additional measurements and genetic material from least terns in Hawai'i and least terns on the Pacific Coast of southern Mexico and Central America to further clarify whether *Sternula antillarum mexicana* and *S. a. staebleri* are distinct subspecies or if there are other isolating mechanisms in these populations. Based on current known information, including that no least tern from one subspecies region has been documented nesting in another subspecies region (Ryan et al. 2025, pp. 3, 13), we conclude that the California least tern subspecies (*S. a. browni*) is not freely interbreeding with members of other least tern subspecies. In the absence of compelling evidence to the contrary, we continue to

recognize the California least tern subspecies as separate from least terns that breed in the Gulf of California and southwestern Mexico for the purposes of the Act and sometimes refer to the formerly accepted subspecies *S. a. mexicana* in this review.

Distribution

Breeding

The distribution of the California least tern has changed little since the previous 5-year review. In the United States, the subspecies nests in California from the San Francisco Bay area to the mouth of the Tijuana River just north of the United States-Mexico border (Figure 1). Starting in 2021, California least terns have begun nesting at one new nesting site¹ in the San Francisco Bay area, San Pablo Bay National Wildlife Refuge (Table 2). However, California least terns have temporarily stopped using other nesting sites, such as Rancho Guadalupe Dunes Preserve and Malibu Lagoon (Table 2). In our previous status review, we included the Salton Sea in Imperial County, California, as a potential California least tern nesting area². While a few least terns are observed breeding at the Salton Sea during some years (CDFW (California Department of Fish and Wildlife) 2025, dataset), this 5-year review does not include the Salton Sea as a California least tern nesting area. The subspecies of least tern that breeds at the Salton Sea is unknown but is more likely to be *Sternula antillarum mexicana* than California least tern (*S. a. browni*) based on proximity to *S. a. mexicana* nesting areas and similarity of habitat (Ryan 2025, pers. comm.).

The exact breeding range of the California least tern in Mexico is uncertain. However, the best available information suggests that this subspecies nests only along the Pacific coast of the Baja California Peninsula (Figure 2; Patten and Erickson 1996, p. 888; Ryan et al. 2025, entire). Not all nesting sites are occupied every year (Figure 1; Figure 2; Table 2; Table 3).

A number of nesting sites have become inactive (extirpated) over the past 35 years (Table 4). While breeding pairs at many of these nesting sites were rarely abundant, some sites had more than 50 breeding pairs during at least one year. These sites include Terminal Island (Los Angeles County), Mission Bay San Diego River Mouth (San Diego County), Punta Banda Dique (Mexico), and San Quintín La Salina (Mexico) (Table 4). While some sites are no longer suitable for breeding (e.g., the Terminal Island and Naval Training Center³), other inactive sites could be future locations for restoration and/or threat reduction.

¹ A nesting site, sometimes referred to as a nesting colony, is a defined area in which California least terns nest in proximity to one another. It is monitored and managed as a single site, i.e., it is not made up of multiple noncontiguous patches that would need to be monitored separately.

² A nesting area generally refers to more than one nesting site that occur in the same area. California least terns may regularly move among different nesting sites within the same nesting area if making multiple nesting attempts. Each nesting site in a given nesting area is generally monitored and managed individually, but usually by the same monitors and managers. Monitoring data from multiple nesting sites within the same nesting area are often combined and reported for the nesting area as a whole. In many cases, some nesting sites in a nesting area are not occupied every year.

³ The Terminal Island and Naval Training Center sites have been developed since they were last used by breeding California least terns. As mitigation for the development of the Terminal Island site, the L.A. Harbor site was

As discussed in the previous 5-year review, a few California least terns have been discovered nesting in areas outside of California or Mexico (Service 2020, p. 8). In 2009, two pairs of least terns, including one banded individual, nested in Glendale, Arizona, and produced one chick (Stevenson and Rosenberg 2009, p. 634; Marschalek 2010, p. 20). The birds were suspected to be of the California subspecies because the banded individual was banded as a chick in San Diego County (Robertson 2009, pers. comm.). This was the first documented least tern nesting in Arizona (Marschalek 2010, p. 20) and least terns have not been documented nesting in Arizona since, except for one possible observation of an adult with two juveniles in Wilcox, Arizona, on May 3, 2013 (eBird 2025, dataset). Breeding least terns are also found in low numbers on Oahu and the Island of Hawai'i in the State of Hawai'i (Harmon et al. 2021, entire; eBird 2025, dataset; Sin 2025, pers. comm.), though the subspecific affinity of these birds is unknown.

created. As partial mitigation for development of the Naval Training Center site, the San Diego National Wildlife Refuge Saltworks site was secured.



U.S. Fish & Wildlife Service

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California least tern (*Sterna antillarum browni*) nesting areas by the average minimum estimated number of breeding pairs (2019-2023)



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Data: USFWS, CDFW
Basemap: ESRI World Terrain
Date: Aug 13, 2025
S:\stem\emilie\ListingRecovery\CLT15\YR_2025\CLT.aprx

- 0 pairs
- 1-20 pairs
- 21-50 pairs
- 51-200 pairs
- 200-400 pairs
- >900 pairs
- ▲ Not reported

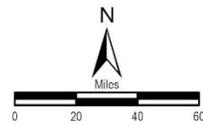


Figure 1. United States nesting areas of the California least tern by average minimum number of nesting pairs (2019–2023).

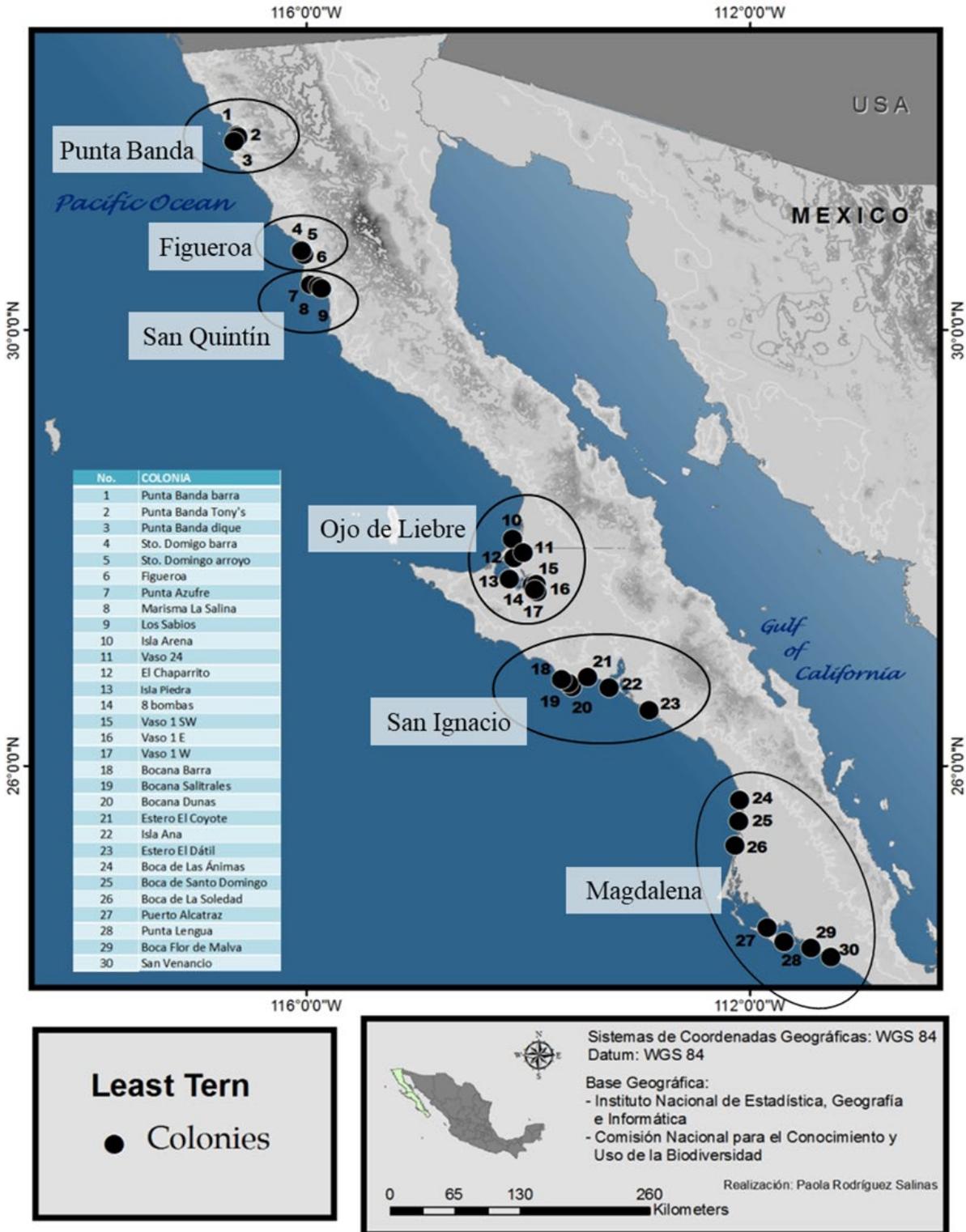


Figure 2. Distribution of nesting sites of the California least tern in Mexico. Circles show the six nesting site clusters for which data are summarized in Table 3. Not all sites are occupied each year. Figure courtesy of Eduardo Palacios Castro.

Table 2. Status of the California least tern (*Sternula antillarum browni*) at currently occupied nesting sites/areas (2012–2023) in California. NR = not reported. N/A = not applicable. Conservation measures were compiled from Frost (2017, appendix B-1), Sin et al. (2024, appendix 1), and Service biologists. Other data were compiled from Service (2020, appendix A), CDFW (2025, dataset), and Conrad (2025, pers. comm.). Asterisk (*) indicates that data are reported as number of nests and fledglings from Foster (2020, pers. comm.) and Foster (2021, pers. comm.).

Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
Sacramento Area	Sacramento Bufferlands	Sacramento Regional County Sanitation District	None	Suitable, intermittently occupied	2023: 0 2022: 0 2021: 0 2020: 1 2019: 2 2018: 1 2017: 1 2016: 1 2015: 1 2014: 0 2013: 0 2012: 1	2023: N/A 2022: N/A 2021: N/A 2020: 1.00–2.00 2019: 0.00–0.00 2018: 0.00–1.00 2017: 0.00–0.00 2016: 2.00–2.00 2015: 1.00–1.00 2014: N/A 2013: N/A 2012: 0.00–0.00	Development, Predation, Contaminants, Food availability
San Francisco Bay Area	Napa Sonoma Marsh Wildlife Area (2 sites)	California Department of Fish and Wildlife	Vegetation removal, chick shelters, predator control in 2019 and 2020 only	Suitable, occupied	2023: 25 2022: 28 2021: 0 2020: 1 2019: 2 2018: 2 2017: 65 2016: 60 2015: 63 2014: 38 2013: 61 2012: 16	2023: 0.15–0.28 2022: 0.00–0.00 2021: N/A 2020: 0.00–0.00 2019: 0.00–0.00 2018: 0.00–0.00 2017: 1.23–1.23 2016: 0.07–0.10 2015: 0.34–0.38 2014: 1.36–1.84 2013: 0.14–0.33 2012: 0.54–1.13	Habitat modification, Sea level rise, Predation, Contaminants, Food availability

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Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
San Francisco Bay Area	San Pablo Bay National Wildlife Refuge	Service	None	Suitable, newly occupied	2023: 2 2022: 39 2021: 39 2012–2020: 0	2023: 0.00–0.00 2022: 0.04–0.21 2021: 0.22–0.51 2012–2020: N/A	Habitat modification, Sea level rise, Predation, Contaminants, Food availability
San Francisco Bay Area	Montezuma Wetlands (3 sites)	Montezuma Wetlands, LLC	Vegetation management, decoys, chick shelters during some years	Suitable, occupied	2023: 21 2022: 2 2021: 13 2020: 22 2019: 9 2018: 13 2017: 7 2016: 4 2015: 12 2014: 15 2013: 25 2012: 18	2023: 0.06–0.71 2022: 0.00–0.00 2021: 0.17–0.31 2020: 0.12–0.14 2019: 0.17–0.33 2018: 0.00–0.00 2017: 0.63–0.71 2016: 0.17–0.25 2015: 0.00–0.00 2014: 0.06–0.07 2013: 0.12–0.16 2012: 0.22–1.67	Development, Habitat modification, Sea level rise, Predation, Contaminants, Food availability
San Francisco Bay Area	Pittsburg Power Plant	Mirant Delta, LLC	Fully-enclosed fence, vegetation management, chick shelters, predator control 2011–2014 only	Suitable, intermittently occupied	2017–2023: NR 2016: 1 2015: 2 2014: 0 2013: 0 2012: 1	2017–2023: NR 2016: 0.00–0.00 2015: 0.00–0.00 2014: N/A 2013: N/A 2012: 0.00–0.00	Development, Habitat modification, Sea level rise, Predation, Contaminants, Food availability

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Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
San Francisco Bay Area	Alameda Point	U.S. Navy	Fully-enclosed fence, vegetation management, chick shelters, predator control	Suitable, occupied	2023: 169 2022: 402 2021: 287 2020: 227 2019: 240 2018: 310 2017: 382 2016: 358 2015: 321 2014: 281 2013: 281 2012: 306	2023: 0.32–0.78 2022: 0.48–0.49 2021: 0.42–0.59 2020: 0.67–1.27 2019: 0.54–1.14 2018: 0.55–0.97 2017: 0.47–0.65 2016: 1.54–1.78 2015: 0.99–1.67 2014: 1.22–1.39 2013: 1.07–1.08 2012: 0.05–0.06	Development, Habitat modification, Sea level rise, Predation, Contaminants, Food availability, Human disturbance
San Francisco Bay Area	Hayward Regional Shoreline	County Parks	Vegetation management, interpretive signs, chick shelters, decoys, predator control	Suitable, occupied	2023: 88 2022: 54 2021: 87 2020: 90 2019: 44 2018: 20 2017: 66 2016: 83 2015: 67 2014: 77 2013: 80 2012: 143	2023: 0.89–1.48 2022: 1.12–1.44 2021: 0.63–0.68 2020: 1.33–1.53 2019: 0.81–1.14 2018: 0.42–0.55 2017: 1.04–1.17 2016: 1.80–1.89 2015: 1.29–1.58 2014: 1.42–1.66 2013: 1.46–1.53 2012: 0.58–1.02	Habitat modification, Sea level rise, Predation, Contaminants, Food availability
San Francisco Bay Area	Eden’s Landing Ecological Reserve (3 sites)	California Department of Fish and Wildlife	Vegetation management, chick shelters during some years, predator control since 2018	Suitable, occupied	2023: 49 2022: 30 2021: 39 2020: 0 2019: 71 2018: 95 2017: 14	2023: 0.05–0.10 2022: 0.09–0.27 2021: 0.02–0.03 2020: N/A 2019: 0.08–0.18 2018: 0.01–0.03 2017: 1.00–2.00	Sea level rise, Predation, Human disturbance, Contaminants, Food availability

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Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
					2012–2016: 0	2012–2016: N/A	
San Luis Obispo County	Oceano Dunes State Vehicular Recreation Area	California Department of Parks and Recreation	Fully-enclosed fence around most of nesting site, vegetation management not needed, interpretive signs, predator control	Suitable, occupied	2023: 40 2022: 39 2021: 41 2020: 43 2019: 31 2018: 27 2017: 44 2016: 46 2015: 50 2014: 45 2013: 43 2012: 42	2023: 0.83–0.88 2022: 0.86–0.95 2021: 0.91–1.17 2020: 0.86–0.88 2019: 1.15–1.23 2018: 1.13–1.30 2017: 0.15–0.16 2016: 1.20–1.28 2015: 1.30–1.38 2014: 1.23–1.29 2013: 1.04–1.30 2012: 0.93–1.00	Habitat modification, Predation, Human disturbance, Food availability
San Luis Obispo/Santa Barbara Counties	Rancho Guadalupe Dunes Preserve	County of Santa Barbara Parks, Chevron Corporation, Service	Incomplete fence (detering few predators), vegetation management not needed, interpretive signs	Suitable, intermittently occupied	2021–2023: 0 2020: 38 2019: 13 2018: NR 2012–2017: 0	2021–2023: N/A 2020: 0.11–0.32 2019: 0.24–0.62 2018: NR 2012–2017: N/A	Predation, Human disturbance, Food availability
Santa Barbara County	Vandenberg Space Force Base (5 sites)	U.S. Space Force	Fully-enclosed fence, vegetation management not needed, interpretive signs, chick shelters, predator control	Suitable, occupied	2023: 33 2022: 38 2021: 24 2020: 8 2019: 43 2018: 49 2017: 19 2016: 21	2023: 0.44–0.52 2022: 0.55–0.61 2021: 0.24–0.33 2020: 0.60–0.75 2019: 0.47–0.49 2018: 0.51–0.71 2017: 0.30–0.42 2016: 0.72–0.86	Development, Predation, Human Disturbance, Food availability

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Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
					2015: 20 2014: 17 2013: 14 2012: 16	2015: 1.32–1.45 2014: 1.00–1.18 2013: 1.27–1.36 2012: 0.56–0.63	
Ventura County	Santa Clara River / McGrath State Beach	California Department of Parks and Recreation	Incomplete fence (detering few predators), vegetation management not needed, interpretive signs	Suitable, occupied	2023: 22 2022: 20 2021: 60 2020: 23 2019: NR 2018: 14 2017: 7 2016: 40 2015: 45 2014: 4 2013: 37 2012: 38	2023: 0.07–0.09 2022: 0.00–0.00 2021: 0.42–0.58 2020: 0.08–0.22 2019: NR 2018: 0.26–0.57 2017: 0.00–0.00 2016: 0.19–0.28 2015: 0.39–0.60 2014: 0.50–0.50 2013: 0.00–0.00 2012: 0.21–0.21	Predation, Human disturbance, Food availability
Ventura County	Ormond Beach	Ventura County, City of Oxnard	Fully-enclosed fence, interpretive signs; habitat restoration, grading, and managed retreat from sea level rise planned for 2025	Suitable, occupied	2023: 15 2022: 23 2021: 16 2020: 15 2019: 80 2018: 67 2017: 25 2016: 15 2015: 0 2014: 18 2013: 6 2012: 6	2023: 0.16–0.47 2022: 0.23–0.43 2021: 0.59–1.50 2020: 0.29–0.60 2019: 0.21–0.23 2018: 0.52–0.66 2017: 0.54–0.80 2016: 0.78–0.93 2015: N/A 2014: 0.00–0.00 2013: 0.00–0.00 2012: 0.00–0.00	Predation, Human disturbance, Food availability
Ventura County	Hollywood Beach	City of Oxnard	Fully-enclosed fence, vegetation management not needed, interpretive	Suitable, intermittently occupied	2023: 0 2022: 9 2021: 0	2023: N/A 2022: 0.00–0.00 2021: N/A	Development, Sea level rise, Habitat

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Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
			signs; habitat restoration and grading occurred in 2025		2020: 11 2019: 0 2018: 0 2017: 0 2016: 0 2015: 15 2014: 77 2013: 117 2012: 0	2020: 0.00–0.00 2019: N/A 2018: N/A 2017: N/A 2016: N/A 2015: 0.00–0.00 2014: 0.26–0.38 2013: 0.15–0.26 2012: N/A	modification, Predation, Human Disturbance, Food availability
Ventura County	Naval Base Ventura County Point Mugu (4 sites)	U.S. Navy	Vegetation management not needed, interpretive signs, chick shelters, predator control	Suitable, occupied	2023: 168 2022: 207 2021: 140 2020: 135 2019: 234 2018: 172 2017: 262 2016: 315 2015: 323 2014: 407 2013: 203 2012: 608	2023: 0.29–0.60 2022: 0.05–0.14 2021: 0.29–0.40 2020: 0.07–0.14 2019: 0.23–0.51 2018: 0.23–0.42 2017: 0.09–0.19 2016: 0.16–0.27 2015: 0.26–0.46 2014: 0.29–0.31 2013: 0.00–0.00 2012: 0.02–0.02	Development, Sea level rise, Predation, Food availability
Los Angeles County	Malibu Lagoon	California Department of Parks and Recreation	Incomplete fence (detering few predators), interpretive signs	Suitable, intermittently occupied	2019–2023: 0 2018: 3 2017: 22 2012–2016: 0	2019–2023: N/A 2018: 0.00–0.00 2017: 0.52–1.14 2016–2016: N/A	Habitat modification, Sea level rise, Predation, Human disturbance, Food availability

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Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
Los Angeles County	Venice Beach	Los Angeles County	Fully-enclosed fence, vegetation management, interpretive signs, chick shelters and decoys during some years	Suitable, intermittently occupied	2023: 0 2022: 1 2021: 33 2020: 24 2019: 0 2018: 2 2017: 0 2016: 2 2015: 8 2014: 47 2013: 12 2012: 0	2023: N/A 2022: 0.00–0.00 2021: 0.14–0.45 2020: 0.54–1.13 2019: N/A 2018: 0.00–0.00 2017: N/A 2016: 0.00–0.00 2015: 0.00–0.00 2014: 1.14–2.13 2013: 0.00–0.00 2012: N/A	Habitat modification, Predation, Food availability, Human disturbance
Los Angeles County	L.A. Harbor / Pier 400	Port of Los Angeles	Fully-enclosed fence, vegetation management, interpretive signs, chick shelters, decoys during some years, predator control	Suitable, occupied	2023: 1 2022: 172 2021: 170 2020: 91 2019: 161 2018: 105 2017: 0 2016: 109 2015: 103 2014: 110 2013: 237 2012: 144	2023: 0.00–0.00 2022: 0.01–0.02 2021: 0.20–0.84 2020: 0.02–1.22 2019: 0.53–0.60 2018: 0.59–0.66 2017: N/A 2016: 0.33–0.64 2015: 0.00–0.00 2014: 0.14–1.02 2013: 0.13–0.62 2012: 0.17–0.24	Development, Predation, Food availability, Contaminants, Overflight disturbance
Orange County	Seal Beach National Wildlife Refuge/ Anaheim Bay	Service	Fully-enclosed fence, vegetation management, interpretive signs, chick shelters, decoys during some years, predator control (no predator control in 2018)	Suitable, occupied	2023: 62 2022: 36 2021: 9 2020: 6 2019: 1 2018: 114 2017: 118	2023: 0.20–0.21 2022: 0.05–0.06 2021: 0.00–0.11 2020: 0.09–0.17 2019: 0.00–2.00 2018: 0.36–0.37 2017: 0.03–0.07	Habitat modification, Predation, Contaminants, Food availability

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Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
					2016: 73 2015: 50 2014: 115 2013: 149 2012: 117	2016: 0.31–0.34 2015: 0.07–0.14 2014: 0.03–0.03 2013: 0.55–0.60 2012: 0.33–0.34	
Orange County	Bolsa Chica Ecological Reserve (5 sites)	California Department of Fish and Wildlife	Fully-enclosed fence at 3 of 5 sites, vegetation management, interpretive signs at 1 site, chick shelters, decoys at 1 site, predator control (no predator control in 2019 or 2020)	Suitable, occupied	2023: 90 2022: 118 2021: 110 2020: 59 2019: 90 2018: 118 2017: 158 2016: 124 2015: 184 2014: 205 2013: 137 2012: 154	2023: 0.32–0.53 2022: 0.13–0.30 2021: 0.09–0.19 2020: 0.00–0.00 2019: 0.45–0.52 2018: 0.55–0.60 2017: 0.03–0.04 2016: 0.30–0.35 2015: 0.27–0.29 2014: 0.27–1.07 2013: 0.23–0.49 2012: 0.05–0.10	Habitat modification, Sea level rise, Predation, Food availability, Contaminants
Orange County	Huntington State Beach	California Department of Parks and Recreation	Fully-enclosed fence, vegetation management, interpretive signs, chick shelters, predator control	Suitable, occupied	2023: 255 2022: 333 2021: 333 2020: 232 2019: 452 2018: 594 2017: 560 2016: 304 2015: 411 2014: 407 2013: 303 2012: 422	2023: 0.12–0.13 2022: 0.21–0.25 2021: 0.04–0.21 2020: 0.01–0.01 2019: 0.16–0.24 2018: 0.10–0.29 2017: 0.04–0.25 2016: 0.30–0.40 2015: 0.25–0.30 2014: 0.34–0.86 2013: 0.30–0.33 2012: 0.17–0.21	Habitat modification, Predation, Human disturbance
Orange County	Burris Island	Orange County	Vegetation management, chick shelters	Suitable, occupied	2023: 6 2022: 11	2023: 0.00–0.00 2022: 0.00–0.00	Development, Habitat

2025 5-year Review for the California Least Tern

Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
		Water District			2021: 16 2020: 12 2019: 14 2018: 14 2017: 12 2016: 6 2015: 18 2014: 16 2013: 17 2012: 11	2021: 0.44–0.44 2020: 0.23–0.33 2019: 0.12–0.14 2018: 0.43–0.43 2017: 0.71–0.83 2016: 0.00–0.00 2015: 0.14–0.17 2014: 0.56–0.63 2013: 0.04–0.24 2012: 0.64–0.64	modification, Predation, Contaminants, Food availability
Orange County	Upper Newport Bay Ecological Reserve	California Department of Fish and Wildlife	Vegetation management, interpretive signs, chick shelters, decoys during some years, predator control in 2018 and 2021–2023	Suitable, occupied	2023: 3 2022: 0 2021: 4 2020: 15 2019: 20 2018: 18 2017: 15 2016: 18 2015: 19 2014: 1 2013: 27 2012: 16	2023: 0.75–1.67 2022: N/A 2021: 0.00–0.00 2020: 0.28–0.33 2019: 0.20–0.20 2018: 0.05–0.06 2017: 0.81–0.87 2016: 0.10–0.11 2015: 0.05–0.05 2014: 0.00–0.00 2013: 0.26–0.30 2012: 0.19–0.25	Habitat modification, Sea level rise, Predation, Food availability, Contaminants
Orange County	Anaheim Lake	Orange County Water District	Incomplete fence (deterring few predators), vegetation management not needed	Intermittently suitable, intermittently occupied	2023: 0 2018–2022: NR 2017: 0 2016: 2 2012–2015: 0	2023: N/A 2018–2022: NR 2017: N/A 2016: 0.00–0.00 2012–2015: N/A	Development, Predation, Human disturbance

2025 5-year Review for the California Least Tern

Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
San Diego County	Marine Corps Base Camp Pendleton (7 sites)	U.S. Marine Corps	Some sites with fully-enclosed fence (others incomplete or no fencing), vegetation management at some sites, interpretive signs at most sites, decoys at 1 site, predator control (no predator control in 2017)	Suitable, occupied	2023: 425 2022: 365 2021: 421 2020: 194 2019: 62 2018: 43 2017: 212 2016: 747 2015: 918 2014: 858 2013: 786 2012: 507	2023: 0.33–0.44 2022: 0.22–0.27 2021: 0.16–0.22 2020: 0.27–0.52 2019: 0.04–0.24 2018: 0.01–0.09 2017: 0.00–0.02 2016: 0.09–0.28 2015: 0.13–0.19 2014: 0.32–0.62 2013: 0.13–0.19 2012: 0.02–0.05	Development, Habitat modification, Sea level rise, Predation, Disease, Food availability, Contaminants, Human disturbance
San Diego County	Batiquitos Lagoon Ecological Reserve (5 sites)	California Department of Fish and Wildlife	Fully-enclosed fence, vegetation management, interpretive signs, chick shelters, predator control (no predator control in 2011)	Suitable, occupied	2023: 205 2022: 233 2021: 271 2020: 72 2019: 481 2018: 667 2017: 658 2016: 414 2015: 296 2014: 311 2013: 443 2012: 550	2023: 0.35–0.43 2022: 0.07–0.11 2021: 0.11–0.15 2020: 0.35–0.89 2019: 0.04–0.06 2018: 0.14–0.15 2017: 0.26–0.34 2016: 0.39–0.48 2015: 0.22–0.48 2014: 0.49–0.86 2013: 0.21–0.37 2012: 0.06–0.07	Habitat modification, Predation, Human disturbance, Food availability
San Diego County	San Dieguito Lagoon Ecological Reserve (4 sites)	California Department of Fish and Wildlife	Incomplete fence (detering few predators), vegetation management, chick shelters, decoys,	Suitable, intermittently occupied	2023: 34 2022: 23 *2021: 22 nests *2020: 15 nests	2023: 0.34–0.65 2022: 0.83–0.83 *2021: 4–24 fledglings *2020: 10 fledglings	Habitat modification, Predation, Food availability

2025 5-year Review for the California Least Tern

Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
			predator control since 2013		2018–2019: NR 2014–2017: 0 2013: 3 2012: 0	2018–2019: NR 2014–2017: N/A 2013: 0.00–0.00 2012: N/A	
San Diego County	Mission Bay (5 sites)	City of San Diego	Fully-enclosed fence, vegetation management, interpretive signs, chick shelters, decoys, predator control	Suitable, occupied	2023: 141 2022: 178 2021: 158 2020: 150 2019: 135 2018: 148 2017: 181 2016: 114 2015: 199 2014: 106 2013: 148 2012: 36	2023: 0.29–0.34 2022: 0.26–0.29 2021: 0.45–0.58 2020: 0.40–0.51 2019: 0.20–0.30 2018: 0.15–0.34 2017: 0.23–0.40 2016: 0.15–0.32 2015: 0.50–0.73 2014: 0.53–0.77 2013: 0.05–0.07 2012: 0.00–0.06	Development (1 site only), Habitat modification, Predation, Human disturbance, Contaminants, Food availability
San Diego County	San Diego Bay: San Diego International Airport Lindbergh Field	Airport Authority	Fully-enclosed fence, vegetation management, interpretive signs, predator control	Suitable, occupied	2023: 8 2022: 9 2021: 5 2020: 5 2019: 13 2018: 14 2017: 21 2016: 31 2015: 8 2014: 67 2013: 91 2012: 102	2023: 1.25–1.50 2022: 0.90–1.33 2021: 0.60–1.20 2020: 0.80–0.80 2019: 0.35–0.46 2018: 0.68–1.00 2017: 0.54–0.81 2016: 0.27–0.55 2015: 0.44–1.13 2014: 0.34–0.69 2013: 0.32–0.37 2012: 0.29–0.35	Development, Habitat modification, Predation, Disease, Contaminants, Food availability
San Diego County	San Diego Bay:	U.S. Navy	Fully-enclosed fence at 2 sites, vegetation management, chick	Suitable, occupied	2021–2023: 0 2020: 3 2019: 3	2021–2023: N/A 2020: 0.33–0.67 2019: 0.25–0.33	Development, Habitat modification,

2025 5-year Review for the California Least Tern

Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
	Naval Air Station North Island (2–3 sites)		shelters and decoys during some years, interpretive signs at 1 site, predator control		2018: 12 2017: 16 2016: 26 2015: 24 2014: 42 2013: 7 2012: 0	2018: 0.07–0.08 2017: 0.05–0.06 2016: 0.15–0.19 2015: 0.11–0.13 2014: 0.10–0.24 2013: 0.60–1.71 2012: N/A	Predation, Food availability, Contaminants, Human disturbance
San Diego County	San Diego Bay: NBC Coronado (4 sites)	U.S. Navy	Fully-enclosed fence at 2 sites and incomplete fence at 1 site (detering few predators), vegetation management, chick shelters at 2 sites, interpretive signs at 2–3 sites, predator control	Suitable, occupied	2023: 596 2022: 719 2021: 972 2020: 908 2019: 717 2018: 744 2017: 804 2016: 748 2015: 707 2014: 556 2013: 714 2012: 803	2023: 0.14–0.21 2022: 0.03–0.04 2021: 0.08–0.12 2020: 0.03–0.04 2019: 0.03–0.05 2018: 0.04–0.06 2017: 0.32–0.59 2016: 0.12–0.26 2015: 0.21–0.24 2014: 0.12–0.34 2013: 0.17–0.22 2012: 0.01–0.02	Habitat modification, Sea level rise, Predation, Food availability, Contaminants, Human disturbance
San Diego County	San Diego Bay: D Street Fill, Sweetwater Marsh Unit, San Diego National Wildlife Refuge	Service / Port of San Diego	Incomplete fence (detering few predators), vegetation management, chick shelters, decoys, interpretive signs, predator control	Suitable, occupied	2023: 29 2022: 64 2021: 77 2020: 5 2019: 77 2018: 95 2017: 112 2016: 106 2015: 105 2014: 100 2013: 113 2012: 37	2023: 0.11–0.14 2022: 0.00–0.00 2021: 0.09–0.16 2020: 0.00–0.00 2019: 0.14–0.16 2018: 0.11–0.16 2017: 0.20–0.24 2016: 0.19–0.21 2015: 0.18–0.33 2014: 0.21–0.35 2013: 0.18–0.28 2012: 0.08–0.24	Habitat modification, Sea level rise, Predation, Food availability, Contaminants, Human disturbance

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Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
San Diego County	San Diego Bay: South San Diego Bay Unit, San Diego National Wildlife Refuge, Saltworks	Service	Incomplete fence (detering few predators), chick shelters, interpretive signs during some years, predator control	Suitable, occupied	2023: 38 2022: 17 2021: 17 2020: 35 2019: 28 2018: 27 2017: 33 2016: 16 2015: 24 2014: 22 2013: 27 2012: 49	2023: 0.17–0.18 2022: 0.08–0.12 2021: 0.10–0.18 2020: 0.05–0.09 2019: 0.03–0.04 2018: 0.03–0.04 2017: 0.05–0.09 2016: 0.24–0.44 2015: 0.34–0.42 2014: 0.31–0.50 2013: 0.05–0.07 2012: 0.01–0.02	Habitat modification, Sea level rise, Predation, Contaminants, Food availability
San Diego County	San Diego Bay: Chula Vista Wildlife Reserve	Port of San Diego	Incomplete fence (detering few predators), vegetation management, chick shelters, decoys, interpretive signs, predator control	Suitable, occupied	2023: 47 2022: 67 2021: 73 2020: 102 2019: 51 2018: 76 2017: 86 2016: 63 2015: 69 2014: 59 2013: 66 2012: 37	2023: 0.09–0.13 2022: 0.03–0.03 2021: 0.01–0.08 2020: 0.15–0.18 2019: 0.04–0.08 2018: 0.07–0.13 2017: 0.18–0.27 2016: 0.21–0.29 2015: 0.43–0.54 2014: 0.27–0.46 2013: 0.44–0.59 2012: 0.35–0.54	Habitat modification, Sea level rise, Predation, Contaminants
San Diego County	Tijuana Estuary National Estuarine Research Reserve (2 sites)	California Department of Parks and Recreation /Service	Incomplete fence (detering few predators), vegetation management not needed, chick shelters during some years, interpretive signs,	Suitable, occupied	2023: 144 2022: 114 2021: 138 2020: 144 2019: 97 2018: 178 2017: 197	2023: 0.21–0.24 2022: 0.18–0.21 2021: 0.09–0.22 2020: 0.08–0.13 2019: 0.05–0.07 2018: 0.08–0.10 2017: 0.35–0.42	Habitat modification, Sea level rise, Predation, Food availability, Human

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Region / County	Name of Nesting Site or Nesting Area	Ownership	Conservation Measures	Current Status	Minimum Number of Breeding Pairs (2012–2023)	Fledglings per pair ratio min–max (2012–2023)	Threats
			predator control		2016: 144 2015: 144 2014: 229 2013: 206 2012: 109	2016: 0.19–0.28 2015: 0.15–0.22 2014: 0.14–0.17 2013: 0.23–0.32 2012: 0.00–0.00	disturbance, Contaminants

Table 3. Estimated numbers of breeding pairs at six nesting site clusters in Baja California, Mexico, 1991–2024. NR = not surveyed or not reported. Asterisk (*) indicates that not all sites in the cluster were surveyed that year. Blank cells for the year 2024 indicate data has yet to be compiled. Data provided by Palacios Castro et al. (Palacios Castro 2008, pers. comm.; Palacios Castro et al. 2025, pers. comm.).

Nesting Cluster	1991	1992	2002	2003	2004	2005	2007	2008	2017	2018	2019	2020	2021	2022	2023	2024
Punta Banda	90	67	67	30	32	59	40	0	28	24	73	104	63	45	0	20
Figueroa	30	20	11	23	18	17	19	13	21	5	60	NR	76	25	20	17
San Quintín	76	44	35	97	76	64	25	37	21	0	31	NR	0	0	0	14
Ojo de Liebre	18	92	0	5	12	40	7	30	45	1*	34*	NR	NR	3*	0*	
San Ignacio	0	33	6	0	41	49	8	61	30	28	22*	NR	NR	NR	17*	
Magdalena	0	20	102	78	43	26	0	40	27	4*	NR	NR	NR	NR	21*	
TOTAL	214	276	221	233	222	255	99	181	172	62	220	104	139	73	58	51

Table 4. Inactive California least tern nesting sites. Data compiled from CDFW (2025, dataset) and Palacios Castro et al. (2025, pers. comm.).

Region	Site name	Number of years with breeding pair(s)	Most recent year with breeding pair(s)	Maximum breeding pairs
San Francisco Bay Area	Albany Central Ave	1	2000	12
San Francisco Bay Area	Oakland Airport	3	1995	6
Kings County	Kettleman City	9	2009	3
San Luis Obispo County	Unocal Chevron, Guadalupe Dunes	1	1994	6
Santa Barbara County	San Antonio Creek	1	1990	1
Santa Barbara County	Coal Oil Point Reserve	5	2004	6
Los Angeles County	Terminal Island	7	1997	56
Orange County	Newport Slough/Santa Ana River Marsh	1	1992	1
San Diego County	Fairbanks Ranch	1	2009	2
San Diego County	Mission Bay: San Diego River Mouth	8	2016	103
San Diego County	Mission Bay: South Shores	1	1998	9
San Diego County	San Diego Bay: Naval Training Center	3	1995	13
San Diego County	San Diego Bay: Silver Strand State Beach	1	2004	1
Punta Banda	Punta Banda Tony's	Unknown	1992	25
Punta Banda	Punta Banda Dique	Unknown	1995	57
Figuroa	Sto. Domingo Barra	Unknown	1993	5
Figuroa	Sto. Domingo Arroyo	Unknown	1993	"several"
San Quintín	San Quintín La Salina	Unknown	2017	68
San Quintín	San Quintín Sabios	Unknown	1993	"several"

Region	Site name	Number of years with breeding pair(s)	Most recent year with breeding pair(s)	Maximum breeding pairs
Ojo de Liebre	Arena	Unknown	1992	10
Ojo de Liebre	Chaparrito	Unknown	2005	3
Ojo de Liebre	Ojo de Liebre Piedra	Unknown	2003	25
Ojo de Liebre	Vaso 1 SW	Unknown	2017	22
Ojo de Liebre	Vaso 1 W	Unknown	1992	13
San Ignacio	La Bocana Barra	Unknown	Unknown	Unknown
San Ignacio	La Bocana Salitrales	Unknown	1991	"a few"
San Ignacio	Isla Ana	Unknown	Unknown	Unknown
San Ignacio	Isla Ana Este	Unknown	Unknown	Unknown
San Ignacio	Estero El Datil	Unknown	Unknown	Unknown
Magdalena	Puerto Alcatraz	Unknown	1985	5
Magdalena	Punta Lengua	Unknown	2002	2
Magdalena	Boca Flor de Malva	Unknown	2003	19

Nonbreeding

The nonbreeding range of the California least tern is not well understood and the observational data available are confounded by other least tern subspecies, which likely co-occur. Least terns depart nesting areas during late summer or early fall and migrate south (Thompson et al. 2020, unpaginated). Least terns of unknown subspecies have been observed during the nonbreeding season in Hawai'i; on the Baja California Peninsula, Mexico; and along the Pacific coasts of mainland Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama (Figure 3; eBird 2025, dataset). There are also scattered sightings of least terns (unknown subspecies) during the nonbreeding season along the coasts of Columbia, Peru, and northern Chile (Figure 3; eBird 2025, dataset). While nonbreeding least terns are also observed in the eastern United States, along the eastern coast of Mexico, in the Caribbean, and along the Atlantic coast of South America (Figure 3), the California least tern subspecies is generally assumed to spend the nonbreeding season predominantly in Pacific coastal marine areas of southern Mexico and Central America (Massey 1981, p. 71; Service 2020, pp. 11–12; Thompson et al. 2020, unpaginated). Supporting this assumption, a California least tern banded at its natal site at Huntington State Beach, California, on June 26, 2022, was spotted as a juvenile 3,850 km (2,392 mi) away at Punta Raton, Sector Sur in Honduras on June 25, 2023 (Ryan, Palacios-Castro, and Ortiz-Serrato, in prep.).

A recent study using stable isotopes sheds additional light on the nonbreeding (August–March) range of California least terns, suggesting that the subspecies may be relying on foraging habitat in the pelagic zone, well away from coastal areas (and thus, away from human observation). The study results support that California least terns and least terns in the Gulf of California migrate south from breeding areas and spend most of their time feeding on lower trophic level prey in the pelagic zone, likely on krill and other filter-feeding crustaceans with occasional supplementation with fish (Morales Flores 2024, p. 43). The stable isotope ratios found in the primary feathers of adult least terns suggest that least terns that breed in California and northwest Mexico share a similar trophic niche during the nonbreeding season, likely spending the season pelagically in the Eastern Tropical Pacific Ocean from Mexico through northern South America (Morales Flores 2024, pp. 36–43).

Additional study is needed to determine more precise locations where California least terns spend their time roosting and foraging during the nonbreeding season. Furthermore, assessing migratory connectivity (i.e., the extent to which individuals from the same breeding area migrate to the same nonbreeding area and vice versa (Webster et al. 2002, p. 76)) is important for understanding the full life-cycle ecology of the subspecies, annual survival, and population dynamics (Webster et al. 2002, pp. 76–78; Marra et al. 2018, pp. 2–4). For example, conditions and events at nonbreeding locations are likely to affect the rate of return and productivity of breeding pairs during the subsequent breeding season. Therefore, it may be crucial to understand conditions at nonbreeding locations in order to understand breeding population dynamics and best direct recovery efforts.

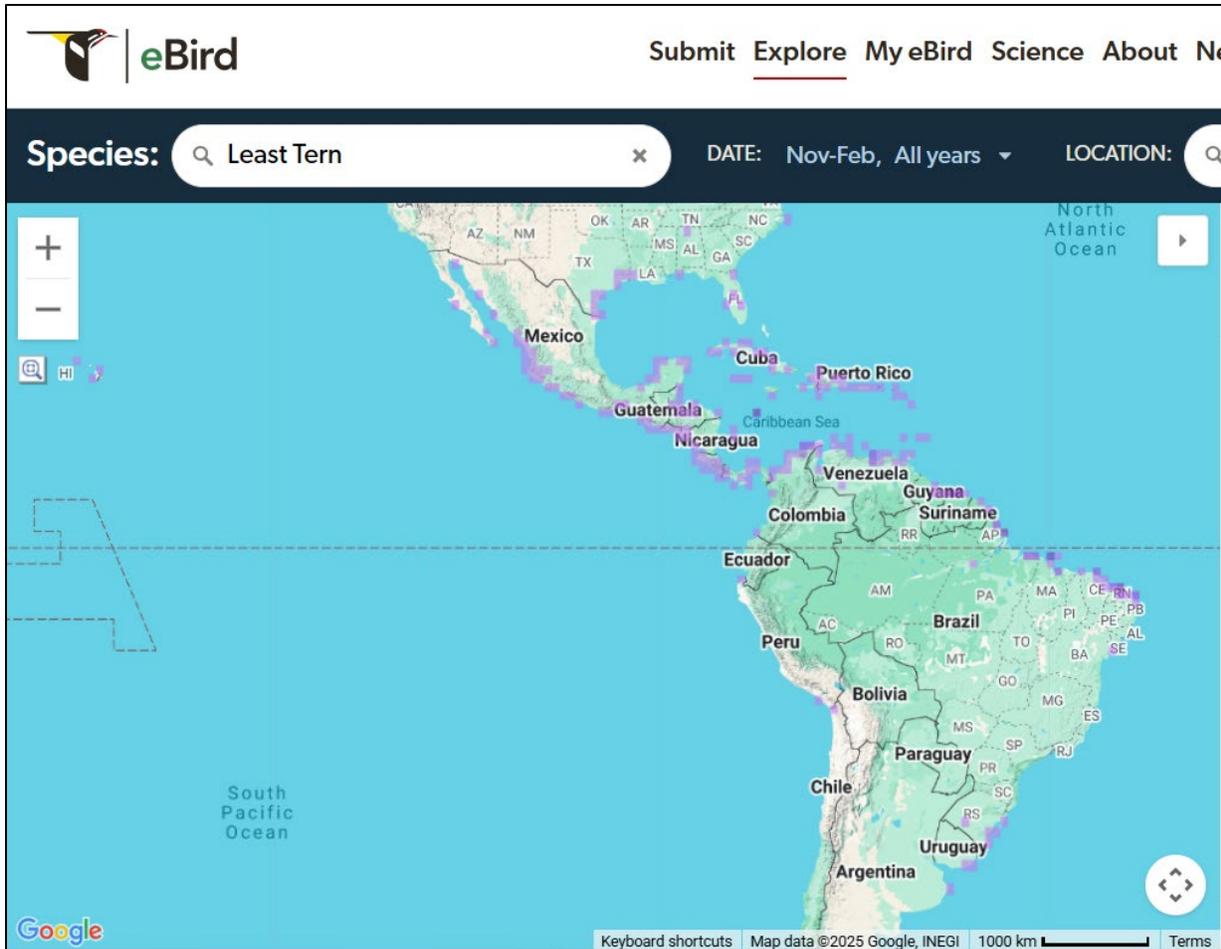


Figure 3. Locations of least tern observations during November–February. Observational data compiled by eBird (2025, dataset).

Abundance and Reproduction

The number of California least tern breeding pairs in the United States has continued in a declining trend since approximately 2010 (Table 5, Figure 4). During 2023 (most recent year of available data), there were approximately 2,716–3,353 breeding pairs that produced 901–1,084 fledglings in California (Table 5). This means that the fledging rate in California was 0.27–0.40 per pair in 2023 (CDFW 2025, dataset). While the number of estimated breeding pairs has decreased over the past 3 years, the number of fledglings estimated has been relatively stable (Figure 4).

In Mexico, California least tern nesting areas are not surveyed every year (Table 3) and with the exception of Punta Banda and San Quintín, most sites are only visited once (in contrast to United States sites, which are monitored throughout the breeding season). In general, nesting sites in Mexico tend to have fewer breeding pairs than sites in the United States. The greatest number of breeding pairs estimated in Mexico was 276 in 1992 (Table 3). Since 1992, breeding pair estimates have decreased, ranging from 255 (in 2005) to 58 (in 2023) but not all sites were

monitored each year (Table 3). During some years, entire nesting area clusters lack breeding pairs (Table 3).

The distribution of California least terns is uneven across their breeding range. The majority of pairs breed in the Southern California Bight region of California, with the San Diego Bay nesting sites having the largest proportion (30 percent), an average of 937 minimum breeding pairs during 2019–2023 (Figure 1). The next most abundant nesting areas (from north to south) are Alameda Point (265 pairs), Huntington State Beach (321 pairs), Marine Corps Base Camp Pendleton (293 pairs), and Batiquitos Lagoon Ecological Reserve (252 pairs) (Figure 1; Appendix A). The nesting area that produces the most fledglings is Alameda Point (average of 187 fledglings per year) (Figure 5; Appendix A). Hayward Regional Shoreline, Marine Corps Base Camp Pendleton, Mission Bay, and San Diego Bay sites are also productive sites, producing 50–100 fledglings per year. The nesting areas that have the highest reproductive success (have the highest fledging to breeding pair ratios) are Hayward Regional Shoreline (0.96) and Oceano Dunes (0.92) (Figure 6; Appendix A). However, the large majority of nesting areas in California have an average annual fledgling ratio of less than 0.25 fledglings per pair (Figure 6).

Table 5. Minimum and maximum estimations of breeding pairs and fledglings for the California least tern in the United States from 2014 to 2023 (CDFW 2025, dataset).

Year	Minimum Breeding Pairs	Maximum Breeding Pairs	Minimum Fledglings	Maximum Fledglings
2014	4232	5786	2136	2859
2015	4202	5295	1514	1887
2016	3989	4661	1612	2000
2017	4097	5598	1131	1655
2018	3741	4502	841	1125
2019	3169	4037	734	958
2020	2670	3738	826	996
2021	3553	4466	801	1076
2022	3351	3795	692	775
2023	2716	3353	901	1084

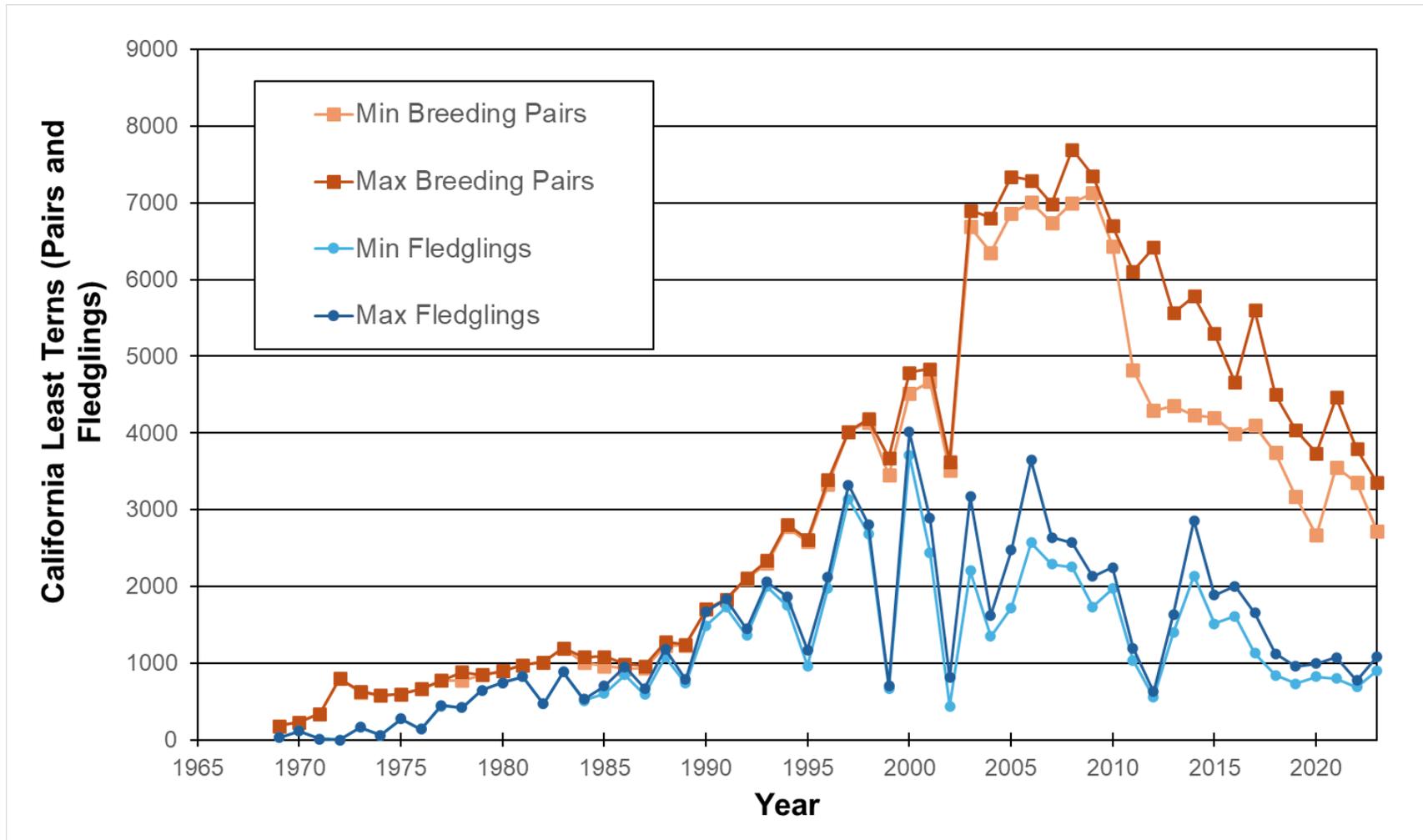


Figure 4. Minimum and maximum estimations of breeding pairs and fledglings produced for the California least tern in the United States from 1969 to 2023 (CDFW 2025, dataset). Statewide surveys with standard methods began in 1973; reliable chick counts began in 1978.



U.S. Fish & Wildlife Service

5-year Review

California least tern (*Sterna antillarum browni*) nesting areas by the average minimum estimated number of fledges (2019-2023)



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2177 Salk Avenue, Suite 250
Carlsbad, CA 92008
(760) 431-9440

Data: USFWS, CDFW
Basemap: ESRI World Terrain
Date: Aug 13, 2025
System:emile.ListingRecovery/CLT15YR_2025/CLT.aprx

- 0 fledges
- 1-10 fledges
- 11-20 fledges
- 21-50 fledges
- 51-100 fledges
- >100 fledges
- ▲ Not reported

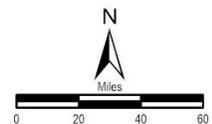


Figure 5. United States nesting areas of the California least tern by average minimum estimated number of fledglings (2019–2023).



California least tern (*Sterna antillarum browni*) nesting areas by the average minimum fledge ratio (2019-2023)



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 (760) 431-9440
 Data: USFWS, CDFW
 Basemap: ESRI World Terrain
 Date: Aug 13, 2025
 SystemName: ListingRecovery\OLTS19R_2025\OLT.aprx



Figure 6. United States nesting areas of the California least tern by average minimum fledgling ratio (i.e., minimum estimated fledglings divided by the maximum estimated breeding pairs) (2019–2023).

Abundance Uncertainty

A recent study used an alternative method to estimate population abundance (compared to the method used to generate the data presented in this section) and found that it produced lower abundance estimates than those reported by site monitors in southern California. Using the mark-recapture Jolly-Seber method, Ryan and Heyne (2020, pp. 29, 32, Table 10) estimated their sampled population to be lower than estimated using minimum breeding pairs counted at the sites during 2016–2018. Mark-recapture population estimates were 16, 94, and 33 percent of the estimates using minimum breeding pairs for 2016, 2017, and 2018, respectively (Ryan and Heyne 2020, p. 29, Table 10). Ryan and Heyne (2020, pp. 29, 32–33) suggest that breeding pairs may have been overcounted due to (1) pairs renesting multiple times at the same site and the nesting site monitors using nest counts as their pair estimate and (2) pairs/nests being counted at more than one nesting site in a single year following abandonment of one or more previous nesting sites due to lack of food or predator disturbance issues.

Life History

Age

Between 1988 and 2019, biologists have banded 63,353 California least tern chicks (mostly within San Diego County), of which 21,834 are estimated to have fledged (Ryan and Heyne 2020, p. 30; Robinette 2021, p. 5). Through recapture efforts, three 26-year-old individuals have been observed nesting (Ryan and Heyne 2020, p. 16, Table 3; Robinette 2021, p. 6). As of 2020, most breeding California least terns are estimated to be between 3 and 20 years of age with an average age of 11–12 years (Ryan and Heyne 2020, p. 30; Robinette 2021, p. 6). The large size of “middle” age class could be the result of high productivity between 1997 and 2008 (Ryan and Heyne 2020, pp. 30–31; Robinette 2021, p. 6).

Earlier studies suggested that California least terns may begin breeding as early as 2 years of age (Massey and Atwood 1981, p. 599). Based on analysis of banding (1988–2019) and recapture (mark-recapture) data, California least terns in southern California appear to begin breeding between 3 and 6 years of age (note that this could be an artifact of recent low recruitment) (Ryan and Heyne 2020, p. 30; Robinette 2021, pp. 5–6).

Natal Dispersal

California least terns are known to exhibit nesting site fidelity, returning to the same nesting site year after year. Adults return to breed at a significantly higher rate where they previously bred successfully or to their natal nesting site (i.e., where they hatched), compared to predictions if birds nested randomly (Atwood and Massey 1988, pp. 391–393). The most recent analysis of mark-recapture data (using banded birds recaptured between 2008 and 2012), found that California least terns are currently dispersing (both north and south) in greater numbers and farther distances from their natal nesting sites (Ryan and Heyne 2020, pp. 23, 31, Table 9) than predicted by previous studies (Atwood and Massey 1988, pp. 391–392; Massey et al. 1992, p. 980, table 3; Collins et al. 1998, pp. 8–9, table 4). Biologists suggest that this could be because of more frequent nesting site abandonments due to insufficient food and predation (Ryan and Heyne 2020, pp. 31–32; Robinette 2021, p. 6). Of the recaptured birds, 36 percent nested at their

natal nesting sites, 32 percent nested within 30 km (19 mi) of their natal nesting sites (or within the same “nest cluster” or nesting area), and 10 percent nested greater than 90 km (56 mi) from their natal nesting site (Ryan and Heyne 2020, p. 31). The farthest dispersers (4 birds) moved 425 km (264 mi) from their natal nesting site of Oceano Dunes State Vehicular Recreation Area to Naval Base Coronado (Ryan and Heyne 2020, p. 25, Table 9). Recapture data has also demonstrated that nesting California least terns regularly move between nesting sites in southern California and nesting sites near Ensenada and San Quintin in Baja California, Mexico (Ryan and Heyne 2020, p. 30).

Movement

As discussed in the 2020 5-year review, there is little to no evidence that California least terns disperse to the neighboring least tern subspecies’ (*Sterna antillarum mexicana*) breeding range in the Gulf of California, Mexico, or vice versa (Service 2020, p. 21). Researchers have expanded their band-resighting and tagging efforts to test the hypothesis that California least terns may be shifting their range to the Gulf of California, but no least tern from one subspecies region has been documented nesting in another subspecies region (Ryan et al. 2025, pp. 3, 13). However, California least terns banded and marked with Motus tags on the Pacific Coast have been detected in the upper Gulf of California during migration (Hernández Alvarez and Ortiz pers. obs. Cited in Ryan et al. 2025, p. 3), indicating that the two neighboring subspecies may share similar southerly migration routes (Ryan et al. 2025, p. 13).

Although California least terns do not appear to move to nesting sites of the neighboring subspecies on the eastern side of the Baja California peninsula, a long-distance movement between nesting sites on the Pacific coast has been observed. In 2022, an individual banded in Punta Azufre, San Quintin, Baja California, Mexico, was later observed in a single sighting on May 16, 2022, at Oceano Dunes State Vehicular Recreation Area in Oceano, California, which is approximately 676 km (420 mi) northwest (Clark 2025, pers. comm.; Ryan et al. 2025, p. 3).

Researchers from the San Diego Zoo Wildlife Alliance recently deployed an array of nine Motus receivers in coastal San Diego County to estimate foraging behavior of 36 California least terns fitted with Motus transmitters (transmitters were glued to birds’ backs) during May–July of 2024 (Vilchis 2025, pers comm.). Nine Motus receivers, each with multidirectional yagi antennas, placed in proximity of each other allowed Vilchis and team to estimate presence/absence of terns at offshore locations triangulated from telemetry data. Most triangulated presence/absence positions were within 10 km (6.2 mi) from each corresponding least tern nesting site, while a few were farther offshore, including near Santa Catalina Island, open ocean south of San Clemente Island, and several miles off the coast of Ensenada, Mexico (Vilchis 2025, pers comm.). Patterns of movement timing and distance traveled while foraging differed between the two sites where birds with transmitters were nesting. California least terns nesting at Naval Base Coronado were less likely to be foraging during midday hours (1100 – 1400 hours) and more likely to travel farther from the nesting site than birds nesting at Marine Corps Base Camp Pendleton (Vilchis 2025, pers comm.).

Diet and Foraging

Seasonal shifts in diet

A recent study examining stable isotopes in primary feathers of adult and juvenile California least terns suggests that diet and feeding strategies differ between the breeding and nonbreeding seasons. Different ratios of stable isotopes in primary feathers of fledglings (grown during the breeding season) and of adults (grown during the nonbreeding season) suggests that there are differences in the prey selected and the geographic location of foraging during the breeding and nonbreeding seasons (Morales Flores 2024, p. iii). The overlap of isotopic ratios in primaries among adults that breed in California and northwestern Mexico indicates that there are similarities in prey selection and location during the molt of primary feathers (nonbreeding season) (Morales Flores 2024, p. iii). Based on the isotopic signature of macroalgae found in the primaries, adult California least terns likely spend most of their time during primary molt feeding on prey of lower trophic levels, likely krill and other filter-feeding crustaceans, and occasionally supplement their diet with fish opportunistically (Morales Flores 2024, p. 43). Isotopic signatures for least tern adults during the nonbreeding season were similar for birds across breeding regions, i.e., California and Baja California, Baja California Sur, Sonora, and Sinaloa (Morales Flores 2024, p. 18, figure 4). In contrast to adults, isotopic ratios in fledgling primaries reflect the foraging strategy for higher trophic level prey (i.e., fish) to feed young during the breeding season and isotopic signatures did not overlap between the two regions where juveniles were sampled, California-Baja California and Baja California Sur (Morales Flores 2024, pp. 18, 36–37, figure 4).

Feeding strategy also varies among individuals and over the course of the primary molt during the nonbreeding season (Morales Flores 2024, entire). Morales Flores (2024, p. 37) found that two fledglings at the same breeding site in 2022 had different isotopic signatures, suggesting that one fledgling was fed a pelagic diet of lower trophic level prey while the other was fed a diet composed of higher trophic level prey from the coast. While adult least terns that breed in California and northwestern Mexico generally followed a pelagic low trophic level diet during the winter of 2021–2022, the isotopic signatures in primaries of many individuals exhibited a pattern of shifting from a low trophic level to a higher trophic level diet during the sequential growth of the ten primary feathers (Morales Flores 2024, p. 38).

Pre-nesting (egg formation)

Another study examined the diet of female California least terns leading up to egg laying⁴ for 2003–2012 through analysis of stable isotopes in egg membranes (Fournier 2016, entire). The results suggest that topsmelt, saury, rockfish, and krill comprised 98 percent of the diet of pre-nesting females nesting in San Diego Bay and Marine Corps Base Camp Pendleton during the 10-year study (Fournier 2016, p. 11). However, the relative proportion of each prey type in diet varied among years. In some years, pre-nesting female diet was primarily krill and saury, while in other years, diet consisted mainly of saury, rockfish and anchovy, or topsmelt (Fournier 2016,

⁴ Egg development was assumed to take place during April–May but could also be influenced by diet during February–March leading up to egg development (Fournier 2016, pp. 27–28).

pp. 11–13). Krill was dominant in the pre-nesting diet during most years, but rockfish replaced krill as a dominant food type during 2005 and 2006 (Fournier 2016, pp. 11–13).

Using egg membrane isotope data for 2003–2023 from San Diego Bay and Marine Corps Base Camp Pendleton, Mills (2024, entire) found a positive relationship between the amount of nearshore (lower trophic level) prey in female diet and fledging rate but noted that other site-specific factors may be at play (Mills 2024, pp. v, 17–19, 34–35). The strength of ocean upwelling (higher pre-conditioning Cumulative Upwelling Index values) and more compressed cold-water habitat nearshore (lower Habitat Compression Index values) also had positive effects on the amount of nearshore prey in their diet and fledging success (Mills 2024, p. 33). These results support the hypothesis that dense, abundant nearshore prey in proximity to nesting sites increases reproductive success by enabling increased nest attendance, greater ability to defend against predators, and more frequent chick provisioning success (Mills 2024, p. 33).

The Fournier (2016, entire) study also compared diet to nesting and reproductive metrics. Diet did not appear to affect clutch size or hatching success, but fledging rates were greater when nesting was initiated later in the season and pre-nesting diets were dominated by nearshore, lower trophic level prey (particularly krill) (Fournier 2016, pp. 10, 16). When egg membranes indicated a pre-nesting diet with greater proportions of higher trophic level prey (i.e., rockfish; associated with pelagic habitat), California least terns at Marine Corps Base Camp Pendleton and Naval Base Coronado initiated nesting earlier in the season but (surprisingly) had lower fledge success (lower rate of fledglings per egg) (Fournier 2016, pp. 13, 16). However, this study did not discuss other influences, such as predation and disturbance, that may have influenced fledge success results. Regarding management implications, Fournier (2016, p. 17) noted that reproductive output will be low during some years because of changes in prey availability or distribution in spite of active conservation management at nesting sites (e.g., site preparation and predator control).

Ocean conditions influence California least tern prey availability, and thus, likely affect diet and reproductive success. Using general linear models, Fournier (2016, pp. 23–37) assessed the influence of local ocean conditions (i.e., upwelling, chlorophyll, and sea surface temperature) to diet and reproductive metrics for California least terns in San Diego Bay. Upwelling during April and May had the strongest relationship with diet during egg development with strong upwelling events being correlated with stable isotopic signatures of lower trophic level (nearshore) prey in egg membranes (Fournier 2016, p. 30).

Nesting season diet

A study used dropped fish and hard parts from regurgitated pellets and fecal samples to assess California least tern diet at two nesting sites (Alameda Point and Purisima Point) between 2001–2012 (Leicht et al. 2023, entire). Diet composition during the rearing/fledging stage differed between sites for both dropped fish (25 percent similar) and fecal samples (26 percent similar) (Leicht et al. 2023, p. 67). The diet of the estuarine-based Alameda Point nesting site was dominated by slender-bodied schooling fishes (e.g., Atherinopsidae, Engraulidae, and Clupeidae) common to San Francisco Bay while the diet of the coastal Purisima Point nesting site was dominated by kelp forest and offshore species (e.g., Embiotocidae and Scorpaenidae) (Leicht et al. 2023, p. 73). Fish species dropped at both sites were deeper-bodied than those consumed, and

contrary to expected, chicks ate larger prey when comparing adult and chick fecal samples at Alameda Point (Leicht et al. 2023, p. 67). The observed difference in size of prey could be because adults prioritize bringing back high-energy prey for chicks while eating smaller prey themselves or because adult fecal samples were from earlier in the breeding season, a period when the available prey fish may have been smaller.

During 2018–2020, Robinette (2021, entire) collected fecal samples during the early (1 May – 15 June) and late (15 June – 31 July) part of the breeding season at eight California least tern nesting sites/areas (Alameda Point, Oceano Dunes State Vehicular Recreation Area, Vandenberg Space Force Base, Naval Base Ventura County Point Mugu, Venice Beach, Marine Corps Base Camp Pendleton, Batiquitos Lagoon Ecological Reserve, and Tijuana Estuary National Estuarine Research Reserve). Diet composition by year and site as proportions of anchovy, rockfish, silversides, killifish, saury, fish larvae, and other are presented in Figure 7 (figure provided by Robinette (2021, p. 5, figure 1)). During all 3 years, birds at the northernmost nesting site, Alameda Point, showed a high occurrence of silverside smelt and relatively low diet diversity (Robinette 2021, p. 4). The author suggests this evidence of a consistent food source likely contributed to the relatively high reproductive output at Alameda Point (Robinette 2021, p. 4). Unexpectedly, results of the concurrent camera study showed that Alameda Point birds had low nest attendance (time parents spend at the nest) and chick provisioning rates (measured as the proportion of analyzed nest camera trap photos that had an adult giving food to a chick) compared to other nesting areas during the three years (Robinette 2021, p. 4). The highest proportions of diet in the “other” category (i.e., alternate food sources; not preferred) were seen in 2020–2021 at the two central California nesting areas, Oceans Dunes State Vehicular Recreation Area and Vandenberg Space Force Base (Figure 7; Robinette 2021, p. 4). Diet at the southern California nesting areas showed the highest diversity with high frequencies of fish larvae, which the author suggests means that a consistent preferred food source was unavailable close to the nesting sites (Figure 7; Robinette 2021, p. 4).

Preliminary results of an ongoing study being conducted by San Diego Zoo Wildlife Alliance also connect diet to sea surface temperature and nest initiation date using nesting data at Marine Corps Base Camp Pendleton and Naval Base Coronado. The unpublished results show a strong relationship between peak nesting and local sea surface temperatures (55–51°F) months prior to the breeding season, presumably because of temperature’s effect on prey fish availability (Vilchis 2025, pers comm.). San Diego Zoo Wildlife Alliance researchers are also collecting telemetry data (via Motus receivers) to document foraging behavior during the breeding season. As described above under the Movement subheading, preliminary results show that California least terns nesting at Naval Base Coronado were less likely to be foraging during midday hours and more likely to travel significantly farther from the nesting site than birds nesting at Marine Corps Base Camp Pendleton (Vilchis 2025, pers comm.). These results suggest that foraging conditions likely differ at relatively fine scales and thus, foraging conditions could negatively influence nest success and fledgling survival at some nesting areas, while not affecting other nesting areas in the same region.

2025 5-year Review for the California Least Tern

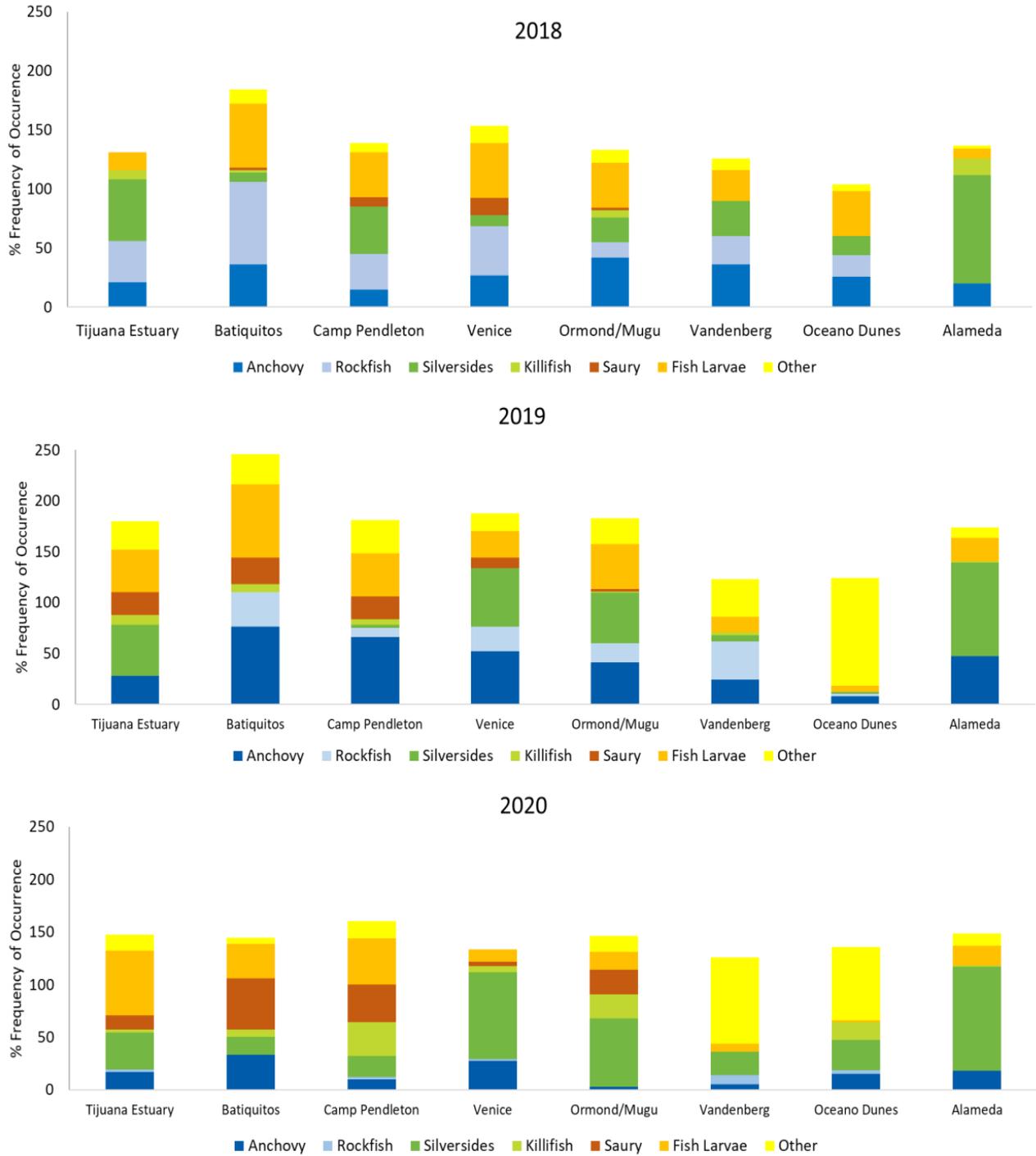


Figure 7. Figure courtesy of Robinette (2021, p. 5, figure 1), “Least tern diet composition expressed as percent frequency of occurrence for the eight [nesting areas/sites] included in our diet study in 2018 through 2020.”

Nest Attendance

Nest attendance (time parents spend at the nest) is positively associated with breeding success and negatively associated with egg and chick predation. Nest attendance and chick provisioning were estimated at five nesting sites (Alameda Point, Vandenberg Space Force Base, Venice Beach, Marine Corps Base Camp Pendleton, and Batiquitos Lagoon Ecological Reserve) using cameras during 2015–2020. Nest attendance rates were consistently highest at Vandenberg (adult incubating nest in more than 80 percent of photos) and lowest at Venice Beach and Marine Corps Base Camp Pendleton (Robinette 2021, pp. 6–8). This likely contributed to the higher fledgling to pair ratios at Vandenberg compared to Venice Beach and Marine Corps Base Camp Pendleton (CDFW 2025, dataset). Nest attendance is assumed to be affected by food availability, where low prey abundance near the nesting sites causes parents to spend more time away from the nest (Robinette 2021, p. 4). Nest attendance is also affected by disturbances (e.g., predators, drones, fireworks, etc.) that cause adults to temporarily leave or abandon nests (see Human Disturbance section).

Conservation

Numerous State and Federal agencies, local government, institutions, organizations, and volunteers actively participate in the conservation of the California least tern annually. In addition to monitoring nesting pairs and fledging success, nesting site managers perform all or some of the following management each year: maintenance of fencing and interpretive signs to explain restricted access, placement of shelters to protect chicks from predators and weather, placement of decoys to attract adults, vegetation management (see Vegetation management), and predator management (see Predator management) (Frost 2017, p. 6). Because nesting areas will continue to require vegetation and predator management even after the population has recovered, the California least tern, is considered a conservation-reliant subspecies.

In addition to monitoring and management, various life history research studies have been initiated or completed in the past few years. Research results and ongoing activities are described in the Life History sections above. Research such as movement, behavior, and diet studies contribute to California least tern conservation because they seek to answer life history questions that, once understood, could clarify specific drivers of population decline and how such drivers can be mitigated.

In February 2024, the Service and the Department of Defense finalized a California least tern Species Action Plan (Service and DoD 2024, entire) through the Recovery and Sustainment Partnership (RASP) Initiative. The RASP was established to better address the dynamic relationship between species needs and mission activities and demonstrates how collaborative partnerships can achieve successes for both military readiness and species conservation. The goal of the Species Action Plan is to improve the status of the California least tern through the development of an implementation strategy that identifies and facilitates implementation of range-wide collaborative conservation actions and improves consistency and coordination among partners. The plan outlines objectives for (1) interagency and stakeholder coordination to develop the implementation strategy, (2) stakeholder commitment to implement tasks and objectives, (3) identification of funding opportunities for priority conservation actions, and (4) evaluation of success of the species action plan and implementation strategy (Service and DoD 2024, pp. 3–6).

THREATS

Development

At the time of listing, nesting habitat destruction from residential and urban development was identified as one of the primary threats to California least tern (Longhurst 1969, pers. comm.; Craig 1971, p. 1) because few protections were in place to preserve nesting habitat while urbanization occurred along the California coast. Decreasing habitat availability has been linked with observed declines in the California least tern and in other least tern subspecies (Massey 1974, pp. 1–2; Fisk 1975, p. 1; Galli 1979, p. 96). Reduced nesting habitat availability has affected the nesting distribution of least terns, which resulted in larger, more concentrated least tern nesting sites, where risk of predation by some species is greater (Brunton 1999, p. 612). Furthermore, development is associated with increased predation of eggs, chicks, and adults by human-associated mammalian and avian predators (Nafarrate 2021, p. 34; Ryan et al. 2025, pp. 13–14).

Today, the majority of California least tern nesting habitat in the United States is on lands that are protected for open space purposes and owned in fee by agencies and organizations. In total, 21 of the 35 currently occupied nesting areas (Table 2) occur entirely on lands currently protected from new development according to the California Protected Areas Database (CPAD 2024, dataset). Several nesting areas that are not currently protected as open space have some level of protection through Biological Opinions, Integrated Natural Resource Management Plans (INRMPs), and Memoranda of Understanding (MOUs). For example, four nesting areas (Naval Air Station North Island, Marines Corps Base Camp Pendleton, Naval Base Ventura County Point Mugu, and Vandenberg Space Force Base) occur on military lands where the Department of Defense (DoD) provides management oversight and increased protection (as required by Biological Opinions or supported by INRMPs, and MOUs). At these nesting areas (and others), the threat of development has been alleviated by protections afforded by the Act and conservation measures for least tern nesting habitat. However, protected areas can still be impacted by development of surrounding areas through unintended habitat modification, increased human-associated predators, and increased disturbances (Nafarrate 2021, pp. 33–34; Ryan et al. 2025, pp. 13–14).

As discussed above, data are limited on California least tern nesting on the Baja California Peninsula. While the Baja California coast is less developed than the California coast, development has long been recognized as an increasing threat in coastal Baja California (Massey 1990, pp. 1100–1102; Palacios Castro 1992, pp. 1–2; Nafarrate 2021, pp. 33–34; Ryan et al. 2025, pp. 3, 15). Though some known least tern nesting sites are within protected areas (such as Punta Banda, Ensenada, Mexico), other nesting sites have various levels of protection. Furthermore, protected sites can still be impacted by development of surrounding areas through unintended habitat modification, increased human-associated predators, and increased disturbances (Nafarrate 2021, pp. 33–34; Ryan et al. 2025, pp. 13–14). Development is a threat to least tern nesting habitat in coastal Mexico, with development likely to increase with increasing human population (Ryan et al. 2025, pp. 3, 15).

In summary, development is a low-to-moderate magnitude threat to the California least tern. Most (but not all) California least tern nesting sites are protected from new development in the

United States. However, existing development and new adjacent development also increases other threats to nesting sites by increasing human-associated predators and disturbances (e.g., noise, trampling, illumination). While development is unlikely to change drastically in the species range in the United States (already heavily developed along the coast), impacts are likely to increase in magnitude in Mexico where some sites are at risk of being developed and/or encroached upon by nearby development.

Reduced Food Availability

We first discussed food availability as a threat, possibly connected to ocean surface temperature changes, in the 2020 5-year review (Service 2020, pp. 55–57). Reduced food availability has the potential to severely impact reproductive efforts and thus the continued persistence of the subspecies. The link between prey fish availability and changes in ocean conditions is well established (e.g., Lehodey et al. 2006, entire; Lindegren et al. 2013, entire). The relationship between food availability for seabirds and human activities, such as commercial fishing and dredging, is less well studied. Commercial fisheries could reduce food availability for California least terns through both direct competition (between commercial fisheries and seabirds for the same fish species) or through depletion of sub-surface predatory fish that drive smaller prey fish to the water's surface, thus making them available to seabirds (Votier et al. 2023, pp. 2383–2385). The potential influence of dredging and beach nourishment on forage fish availability is discussed in the Human Disturbance section.

Reduced food availability is now generally considered to be a likely driver of the declines in the California least tern breeding population and productivity. It is considered a threat at most nesting areas in California (Table 2) and possibly in Mexico (Palacios and Alfaro 2005, p. 154). Food availability near nesting sites affects the California least tern population in two main ways. First, adults may choose to forego nesting, or to abandon eggs or chicks, when food is scarce. Second, limited availability of prey necessitates that adults spend longer periods away from the nesting site (affecting incubation, food delivery rates, and increasing likelihood of egg, chick, and adult⁵ predation at nesting sites) and travel longer distances, which increases energy expenditure.

While more information is needed to clarify the relationship between food availability and California least tern survival and productivity, recent evidence and research support that reduced food availability is affecting the subspecies. At several large nesting areas/sites in southern California, a trend of decreasing clutch size has been observed and chick mortality not caused by predation has ranged from 35 to 39 percent (Ibarguchi 2020, p. 7). At Marine Corps Base Camp Pendleton, poor body condition and starvation have been the main findings in subsets of necropsies of dead chicks and fledglings since at least 2015 (Wooten et al. 2021, p. 36; Wooten et al. 2023, p. 35). At Batiquitos Lagoon Ecological Reserve, 128 chicks and fledglings were found to have died from starvation (based on necropsies of a subset of 10 individuals) in 2017 (CDFW 2017, entire). At the Huntington State Beach nesting site, egg nonviability and nest abandonment have been leading causes of nest failure (Zemba et al. 2025, p. 8). While nest abandonment can be caused by human disturbances or predation, prey availability is believed to

⁵ Risk of adult predation may increase at nesting sites if there are fewer adults present to deter and chase off predators that consume adults, e.g., peregrine falcons.

be a contributing factor to nonviability and abandonment (Zemba et al. 2025, pp. 8, 10–11). In 2019, chick mortality was reportedly high in early June at Huntington State Beach (and other nesting sites) (Ibarguchi 2020, p. 5). These chick mortalities were attributed to poor food availability because few fish prey deliveries were observed and necropsies of chicks at other sites confirmed that poor body condition (starvation) was the cause of mortality (Ibarguchi 2020, pp. 5–6).

Two recent studies, described above under the Diet and Foraging subheading, support our understanding of the relationship among ocean conditions (affected by climate), food availability, and California least tern productivity. Mills (2024, entire) found a positive relationship between the amount of nearshore (lower trophic level) prey in female diet and fledging rate. This supports the hypothesis that dense, abundant nearshore prey in proximity to nesting sites increases reproductive success by enabling increased nest attendance, greater ability to defend against predators, and more frequent chick provisioning success (Mills 2024, p. 33). The strength of ocean upwelling (higher pre-conditioning Cumulative Upwelling Index values) and more compressed cold-water habitat nearshore (lower Habitat Compression Index values) also had positive effects on amount of nearshore prey in diet and fledging success (Mills 2024, p. 33). Preliminary Motus tracking study results show that California least terns nesting at some sites travel significantly farther from the nesting site than birds nesting at other sites (Vilchis 2025, pers comm.), which is also supported by site-level differences in nest attendance at other study sites (Robinette 2021, pp. 6–8). These results suggest that foraging conditions likely differ at relatively fine scales.

In summary, reduced food availability is a moderate-to-high magnitude threat. There is a growing body of evidence showing that trends in ocean conditions are negatively affecting food availability near nesting areas, and thus negatively affecting the California least tern population at a range-wide scale. We expect the threat of reduced food availability to continue, and potentially worsen, in the future.

Predation

At the time of listing, nest predation was considered a significant threat to the California least tern, and a major cause of nest failure (Craig 1971, p. 7, Appendix). Since listing, nest predation and predation in general has continued to be a significant threat (Service 2020, pp. 38–44). At least 54 taxa (33 birds, 18 mammals, 1 reptile, and 2 invertebrates) are known to prey on California least tern eggs or chicks (Marschalek 2009, p. 12, Table 6; Marschalek 2010, p. 12, table 6). Predation, especially of eggs and chicks, is a natural aspect of the California least tern's breeding ecology. However, in California, changes to breeding habitat, adjacent development, predator populations, and California least tern nest attendance have drastically increased predation pressure. Historically, nesting habitat was more plentiful, and nests were much more widely scattered and hard for predators to detect (Massey 1974, pp. 17–18). Today, most of the California least tern population is densely packed into relatively small, static, nesting sites. While denser breeding populations have historically helped with defense of nesting sites from predators, changes to habitat and predator populations (discussed below) have altered the subspecies' ability to successfully defend nesting sites. These dense populations with large numbers of birds are now subject to frequent and high levels of predation because they present a

large source of prey concentrated in a small area (Massey and Atwood 1982, p. III–6; Burger 1984, p. 66).

Changes to coastal habitat through development and planting of trees have also influenced the type and number of predators in the vicinity of nesting sites. Development and urban sprawl proximal to nesting sites is associated with increased predation by native and nonnative human-associated mammalian and avian predators (Nafarrate 2021, p. 34; Ryan et al. 2025, pp. 13–14). Populations of native predatory species, such as American crow (*Corvus brachyrhynchos*), common raven (*Corvus corax*), American kestrel (*Falco sparverius*), Cooper’s hawk (*Accipiter cooperii*), striped skunk (*Mephitis mephitis*), and raccoon (*Procyon lotor*), can be artificially high around urban areas and urban interfaces due to their ability to exploit garbage and other food sources attributable to humans (Garrott et al. 1993, pp. 946, 948; Bolger et al. 1997, pp. 411, 416). Existing urban development also increases the presence of nonnative predators, such as Virginia opossum (*Didelphis virginiana*), rats (*Rattus* spp.), and domestic cats (*Felis catus*). Furthermore, development and landscaping adjacent to nesting sites can introduce predator perches with a line-of-sight into the nesting site, making all life stages of California least terns more susceptible to avian predation. Historically, coastal nesting habitat was devoid of trees or other perching structures that avian predators rely upon for hunting. Trees, buildings, and other tall structures are now abundant along the coast, creating habitat for avian predators that would have once been rare in California least tern nesting areas. Habitat loss and fragmentation resulting from development also decreases the availability of foraging habitat for resident predators and thus increases resident predator concentrations on the small remaining foraging habitat, which includes California least tern nesting sites.

Predators can devastate California least tern reproductive success through direct mortality of eggs, chicks, fledglings, and adults (varies by predator) as well as indirectly through nest or nesting site abandonment (Massey and Fancher 1989, pp. 352–353). Eggs and chicks are the most frequently depredated life stages; both are vulnerable and provide an easy source of food for invertebrates, rodents, skunks, opossums, raccoons, feral cats, and several species of birds. If a predation event is particularly disruptive or causes heavy losses, adults may abandon a nesting site for one or more seasons, even while nests are active. Associated to the threat of reduced food availability, nesting California least terns spend more time foraging at distances farther from the nesting site when prey resources are scarce. This behavior results in decreased nest attendance (longer absences from nesting sites), which reduces the nesting site’s ability to defend against predators.

Although the list of known and suspected predators is long, a smaller number of species pose consistent threats. Many such predators target a nesting site, move between nests taking eggs or chicks, and return repeatedly until the food supply is reduced to a volume not worth pursuing. These predators can cause significant loss to a California least tern nesting site in a matter of hours or days (Fancher 1989, pp. 3–6; Massey et al. 1992, pp. 980–981). The predators that have the largest impacts also shift over time and vary by site and year. In 1992, Fancher (1992, p. 62) reported that northern harrier (*Circus hudsonius*), American kestrel, burrowing owl (*Athene cunicularia*), American crow, loggerhead shrike (*Lanius ludovicianus*), van Rossem’s gull-billed tern (*Gelochelidon nilotica vanrossemi*), coyote (*Canis latrans*), peregrine falcon (*Falco peregrinus*), red fox (*Vulpes vulpes*), domestic cat, and old-world rat species were the most common predators, and caused the most significant impacts. Based on the most recent California

statewide reports for the California least tern, the predators responsible for the greatest number of predation during 2017–2019 were coyote, corvids (common raven and American crow), peregrine falcon, red fox, and owl species (especially great-horned owl (*Bubo virginianus*)) (Figure 8; Sin 2021, pp. 77–97, appendices A-7 and A-8; Sin et al. 2024, pp. 65–82, appendices 7A, 7B, 8A, and 8B). However, the red fox predations (131 eggs) were all attributable to a single nesting area (i.e., Eden’s Landing Ecological Reserve) in 2018 (Sin et al. 2024, p. 65). While the most common predator, coyote, accounts for 40 percent of all 2017–2019 predations (when predator type was reported), avian predators account for nearly half (47 percent) of predations (Sin 2021, pp. 77–97, appendices A-7 and A-8; Sin et al. 2024, pp. 65–82, appendices 7A, 7B, 8A, and 8B).

Falcons, common ravens, and American crows are increasingly abundant in the urbanized areas of southern California and capable of precluding initial nesting and sometimes causing abandonment of the site (Coates et al. 2021, p. 363; Zembal et al. 2025, p. 11). For example, all nests initiated at Venice Beach in 2018 (5 nests) and 2019 (6 nests) were depredated by American crows (Robinette 2021, p. 6; CDFW 2025, dataset). At Marine Corps Base Camp Pendleton (which has active predator management) in 2022, approximately 30 nests were depredated by common ravens, most by a single raven on one day (Wooten et al. 2023, p. 31). This followed near complete reproductive failure from predation when predator management did not occur at Marine Corps Base Camp Pendleton in 2017 (Wooten et al. 2017, pp. 57, 60, 67). The most common predators detected at Marine Corps Base Camp Pendleton during 2017 were common raven, coyote, and American crow (Wooten et al. 2017, p. 64, table 5). Following the intense predation by coyotes and avian predators in 2017, the breeding population has not yet recovered to pre-2017 breeding pair abundances (Wooten et al. 2021, p. 29; CDFW 2025, dataset).

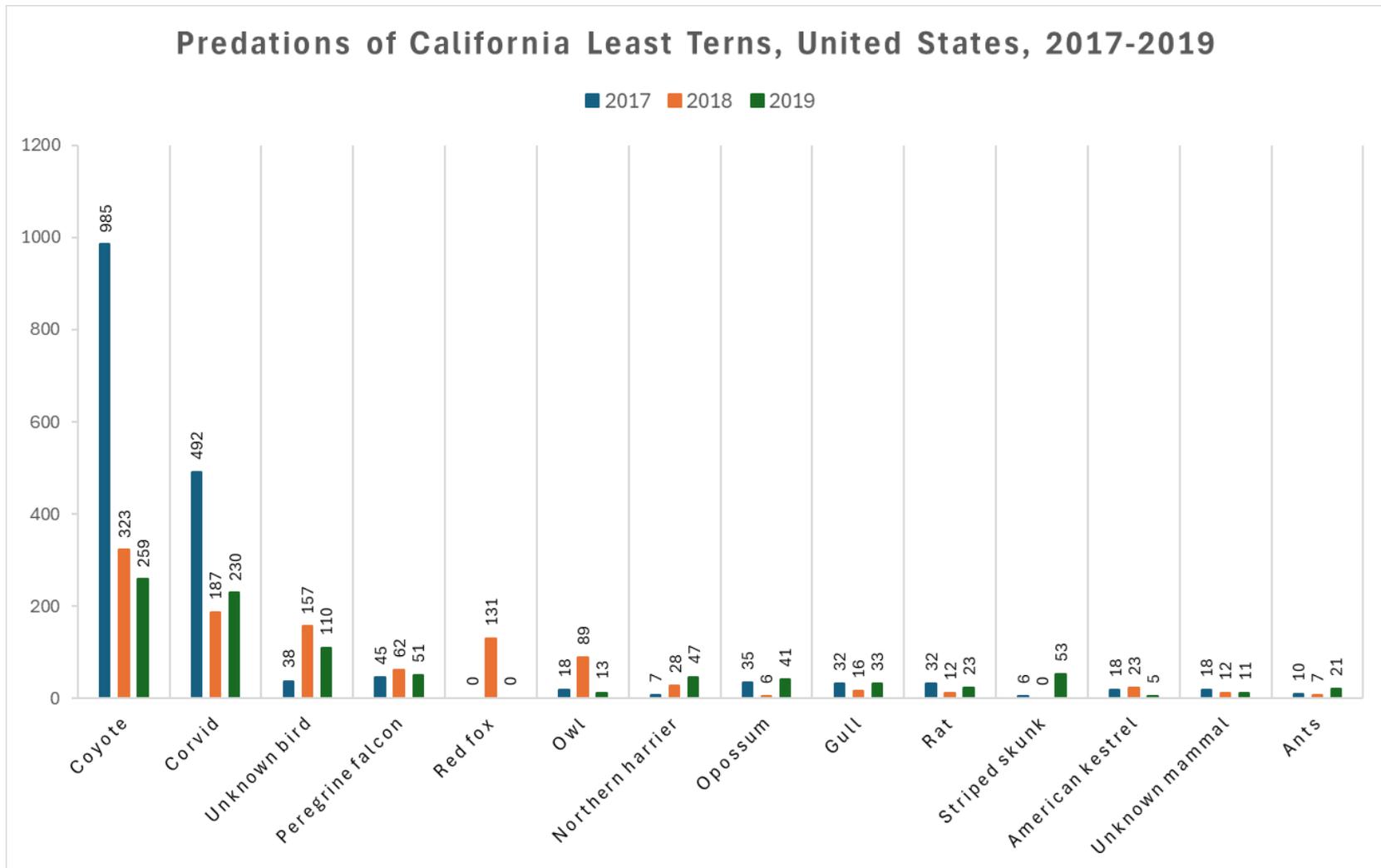


Figure 8. Total documented, suspected, and possible predations of California least tern eggs, chicks, juveniles, and adults by top predator types during the 2017–2019 breeding seasons in California, United States. Figure excludes predations by unknown predators and predators with fewer than 33 predations for 2017–2019. Data were compiled from Sin (2021, pp. 77–97, appendices A-7 and A-8) and Sin et al. (2024, pp. 65–82, appendices 7A, 7B, 8A, and 8B).

The increasing presence of peregrine falcons near nesting areas has become a significant threat to the California least tern (Service 2020, pp. 42–44). Peregrine falcons primarily prey upon adult or fledgling California least terns, which is more impactful than predation of eggs and chicks because adult survival is one of the most influential factors on population growth of beach-nesting birds (Hitchcock and Gratto-Trevor 1997, p. 530). The risk of predation to adults may also make nest and nesting site abandonment more likely (e.g., Jackson 2025, p. 6). While raptors that habitually prey on least terns can be moved by permitted individuals to locations away from nesting areas, peregrine falcons (and northern harriers) are especially difficult to manage because they can quickly return to their home range after relocation. In general, if a nesting (eggs or young in the nest) raptor is relocated, it returns to the area of capture the same season; but if the raptor is not nesting (or most of the young have fledged), it will not return quickly (Skalos 2024, pers comm.). However, peregrine falcons that do not initially return to the place of capture may return the following nesting season to prey upon the same California least tern nesting sites (Skalos 2024, pers comm.).

A single peregrine falcon can be a consistent threat to a nesting area over several years. A male peregrine falcon targeted the California least tern nesting area at Marine Corps Base Camp Pendleton in San Diego County repeatedly from 2014 to 2023. The male was captured and relocated to the California-Oregon border (which is as far away as permits allow) in both 2014 and 2016 but then returned back to the same San Diego nesting area (Skalos 2024, pers comm.). In 2023, the same male depredated at least 20 adult California least terns before capture and placement in captivity at a zoo (Skalos 2024, pers comm.).

Threats from predation by gull-billed terns and burrowing owls were discussed in detail in the 2020 5-year review (Service 2020, pp. 42–43). Like the peregrine falcon, these bird species are of conservation concern; therefore, management options are more limited than with other predators. While burrowing owls have limited impact on California least terns because of the owl's small distribution, gull-billed terns experienced a population expansion that resulted in an oversized predation impact on California least tern eggs and chicks during 2007–2012 (Service 2020, pp. 42–43). However, predation by gull-billed terns has remained relatively low since it fell in 2013 following a parasite-related die-off of the gull-billed tern population (Frost 2017, p. 14; Sin et al. 2024, pp. 68–82, appendices 7A, 8A, and 8B).

In Mexico, the most problematic predators at California least tern nesting sites are coyotes and the human-associated predators of dogs, feral cats, and common ravens (Palacios Castro 2008, pers. comm.; Ryan 2024, pers. comm.). Many sites in Mexico lack the same degree of urbanization that characterizes many California least tern nesting areas in the United States. Therefore, though predation is likely affecting California least terns nesting in Mexico, it is likely that predation rates are lower compared to United States nesting areas, especially by avian predators.

Predator management

Management activities have reduced the magnitude of predation to the California least tern. However, efforts to implement predator management are challenging because of the variety of species that prey on the terns, the expense of using multiple strategies, and, in some cases, barriers or restrictions to using certain types of predator management techniques. Predator

management techniques, target species, and effectiveness vary among sites; and even sites with intensive predator management and control can experience significant losses from predation.

Installing fencing around nesting sites can be an effective deterrent to mammalian predators (in addition to reducing the threat of human disturbance). However, maintenance of fencing is ongoing and needed to be effective against mammalian predators. Furthermore, some fencing needs to be removed and installed annually (to allow access to the area for other uses), which increases ongoing management costs. Approximately 25 of the 59 nesting sites (42 percent) in California monitored in 2019 have a complete fence or barrier that excludes most mammalian predators (Sin et al. 2024, pp. 33–38, appendix 1B).

Placing ceramic roofing tiles or wooden chick shelters near nests are another way that some sites reduce risk of predation. These structures have small spaces beneath them that, when used, provide chicks cover from predators as well as protection from the sun. Approximately 33 of the 59 nesting sites (56 percent) in California monitored in 2019 provided chick shelters at nesting sites (Sin et al. 2024, pp. 33–38, appendix 1B).

Predator control (lethal or nonlethal control of predators) is another management tool that is currently used at approximately half of the California least tern nesting areas in California (Table 2). This usually involves actively trapping and removing predators (mammalian and avian) from nesting areas. Other types of control could also employ toxicants or pesticides while following all applicable laws and product labels.

Because avian predators cannot be excluded from nesting sites through fencing, management of avian predators typically requires ongoing predator control and constant vigilance. However, predator managers also work to deter avian predators by removing perches and installing anti-perch materials on fences, posts, and buildings. For example, recent (2024–2025) efforts have been made at Huntington State Beach to install anti-predation devices on the fencing surrounding the nesting site to deter raptors from perching (Zemba et al. 2025, p. 11). In addition, outreach to discourage American kestrel nesting (by keeping palm skirts trimmed) has been made in neighborhoods surrounding Huntington State Beach (Zemba et al. 2025, p. 11). The effectiveness of perch-deterrents has been questioned and requires additional study.

Much of California least tern predator management is a result of consultation or Habitat Conservation Plans (HCPs) under the Endangered Species Act. Multiple Federal, State, and private landowners provide predator control at least tern sites they oversee, including Pittsburg Power Plant, Alameda Point, Hayward Regional Shoreline, Eden’s Landing Ecological Reserve, Oceano Dunes State Vehicular Recreation Area, Vandenberg Space Force Base, Naval Base Ventura County Point Mugu, L.A. Harbor/Pier 400, Seal Beach National Wildlife Refuge/Anaheim Bay, Bolsa Chica Ecological Reserve, Huntington State Beach, Marine Corps Base Camp Pendleton, Batiquitos Lagoon Ecological Reserve, San Dieguito Lagoon Ecological Reserve, Mission Bay, San Diego Bay, and Tijuana Estuary National Estuarine Research Reserve. These management activities include reducing predator perches at nesting sites, fencing of nesting sites, and lethal and non-lethal control of predators.

As a result of predator management, California least tern reproductive success and survival increased in the late 1980s and early 1990s, greatly contributing to the overall breeding

population (Fancher 1992, p. 62). Initiation of predator control mechanisms at most nesting sites in the United States in the late 1980s is associated with an increased rate of population growth (Figure 4) (Fancher 1992, p. 62, Figure 1). Shwiff et al. (2005, p. 285) performed a cost-benefit analysis and found a positive relationship between funds invested in predator management and reproductive success of terns at Marine Corps Base Camp Pendleton. The numbers of California least tern pairs tripled 6 years after predator management began in 1995 (Shwiff et al. 2005, p. 285). Therefore, predator management has resulted in increased California least tern population numbers and higher productivity.

On military-owned lands, predator control has been consistently funded, increasing productivity and preventing California least terns from abandoning sites in the middle of the season due to predator pressure. Predator control on public lands is subject to annual budgets and other state and federal requirements. Some contractual delays have resulted in late initiation of predator management efforts in some years. In 2017, predator management was not conducted on Marine Corps Base Camp Pendleton due to contracting issues. The lack of predator control resulted in near zero productivity for the year with only four fledglings in 2017 (CDFW 2025, dataset). Nesting has largely failed at sites that lack predator control (e.g., San Elijo Lagoon).

In Mexico, predator management at least tern nesting sites is uncommon. Some of the barriers to implementation of predator management in Mexico include restrictions on using firearms and lack of predator control training (Sin 2025, pers. comm.). We are aware of implementation of predator deterrents at only the northernmost California least tern nesting area in Mexico, Punta Banda. Pro Esteros, a conservation organization in Mexico, has been maintaining rope-fence flagging and motion-activated speakers since 2020 to deter canine and feline predators during the nesting season (Ortiz 2025, pers. comm.). The nesting area at Punta Banda has been monitored since 2016 and has often supported more than 60 breeding pairs (Ortiz 2025, pers. comm.). However, all nests and chicks were depredated before fledging until predator deterrents were installed in 2020 (Ortiz 2025, pers. comm.). More information is needed to determine the effectiveness of these deterrent techniques at California least tern nesting sites in Mexico.

Summary

Predation is a high-magnitude threat in the United States and Mexico. Predators continue to impact California least terns, particularly at the egg and chick stage, but also at the juvenile and adult stage. Certain predators, such as peregrine falcons, American crows, and common ravens, are becoming increasingly problematic at nesting sites in the United States. Compared with the United States, the level and effect of predation is potentially lower in Mexico given the reduced level of urbanization; however, predator control programs are more lacking in Mexico. While the magnitude of predation has been reduced through implementation of some level of predator management at 48 of 59 (81 percent) California nesting sites, it remains a driver of California least tern population dynamics. Increasing predator management at sites where there is little or no existing management, as well as improving predator management techniques, would further decrease impacts from the threat of predation. We expect this threat to continue into the future and potentially to increase in Mexico with expanding development and urbanization near nesting areas.

Habitat Modification Due to Encroaching Vegetation

Encroaching vegetation at nesting sites has been recognized as a threat since California least terns in California were pushed into marginal habitat by development and human use of beach habitat (Longhurst 1969, pers. comm.; Massey 1974, pp. 3, 5; Service 1985, pp. 21, 37; Dunn 1987, pp. 442–443; Service 2006, pp. 14–15; Service 2020, pp. 30–31). The California least tern traditionally nested on sandy beaches close to estuaries and coastal embayments relatively free from human disturbance (Grinnell and Miller 1944, p. 175; Garrett and Dunn 1981, pp. 194–195). They prefer beachfront habitat with sparse or low-lying vegetation and low disturbance from humans and mammalian predators. Because human activities have largely displaced least terns from nesting on beaches in California, most current nesting sites are on modified and semi-developed lands, such as dikes, dredge spoils, and sand-topped islands specially created for California least terns around bays and estuaries, and airports. Such human-made sites are largely removed from the natural disturbance regimes that prevent or limit plant growth and are subject to ongoing vegetation encroachment by both native and nonnative plants. Least terns avoid or abandon areas with dense or tall vegetation as it has the potential to conceal predators (Burger and Gochfeld 1990, pp. 31, 38; Mazzocchi and Forsys 2005, pp. 77–78). Costly annual vegetation maintenance is necessary at many sites in California to maintain suitability of sites prior to each nesting season.

In Mexico, several California least tern nesting sites still occur in coastal beach areas with natural sand transport systems. Therefore, encroachment of vegetation is less of a threat to least tern nesting habitat in Mexico, compared to the United States. We are only aware of vegetation management at one nesting area in Mexico. Pro Esteros has removed trash and nonnative vegetation (ice plant and sea rocket) at Punta Banda (near Ensenada, Mexico) during 2020–2024 (Ortiz 2025, pers. comm.). Given the potential for increased development along the coast of Baja California (which carries the risk of introduction of nonnative vegetation), the threat of vegetation encroachment could increase at nesting sites in Mexico.

Vegetation management

The threat of encroaching vegetation has been decreased through annual pre-breeding season nesting site preparation. At many sites, this involves vegetation removal mechanically, manually, with herbicide, or a combination of methods, prior to the nesting season (Sin et al. 2024, pp. 24–38, Appendices 1A–1B). This necessary management is identified in INRMPs (for sites on military installations), in Biological Opinions, and in HCPs. For example, the HCP for the City of San Diego, known as the City of San Diego Subarea Plan under the MSCP (Multiple Species Conservation Plan) recommends vegetation management at sites under its ownership, and recommends measures to reduce edge effects that could degrade nesting habitat (City of San Diego 1997, p. 160). Many additional sites implement vegetation management on a yearly basis through local funding.

As described in the 2020 5-year review, lack of funding, lack of personnel, or contractual delays sometimes hinder pre-breeding season site preparation (Service 2020, p. 31). If funding and/or personnel are not directed towards site preparation, areas could become unsuitable for nesting. In 2019, approximately 65 percent of the 59 monitored nesting sites required vegetation management but three sites—where it was needed—did not receive management, making them

unsuitable or less suitable for the 2019 nesting season (Sin et al. 2024, pp. 33–38, Appendix 1B). Therefore, vegetation encroachment remains a serious concern that can be reduced by permanent sources of funding and consistent prioritization by landowners and managers.

Summary

Habitat modification due to encroaching vegetation at nesting sites is a low-to-moderate magnitude threat (with management) in the United States and a low-magnitude threat in Mexico. If unmanaged, the threat magnitude would be significantly greater in the United States. Most nesting areas in California are affected by vegetation encroachment by both native and nonnative plants. Vegetation encroachment is less of a threat to nesting habitat in Mexico where nesting sites still occur in coastal beach areas with natural sand transport systems. Sea level rise across the California least tern's range and potential introduction of invasive species through development in Mexico could increase the magnitude of this threat in the future. Sea level rise is a concern because it will force California least terns to nest further inland where there is more vegetation. Continued vegetation management in the United States, where most nesting areas already require management, is likely to keep this threat at a low-to-moderate magnitude, whereas this threat may increase in Mexico without increased vegetation management.

Human Disturbance

At the time of listing, human disturbance of nesting sites was identified as one of the primary threats to California least tern (Longhurst 1969, pers. comm.; Craig 1971, p. 1). A range of human disturbances currently threaten the California least tern in or near nesting areas (Table 6). Some activities can cause direct mortality in addition to altering California least tern behavior (Table 6). Seabirds respond to humans as they do to predators (Frid and Dill 2002, p. 1), resulting in altered foraging, breeding, and sheltering behavior, decreased nest attendance (affecting incubation and nest defense), and reduced feeding of young (Verhulst et al. 2001, p. 379; Ruhlen et al. 2003, p. 303). Flushing events can also attract predators to a nesting site and temporary displacement of adults increases the risk of predation to eggs and chicks. These alterations in behavior can result in decreased fitness of adults and chicks or cause complete nesting site failure (Burger 1984, p. 66; Frid and Dill 2002, p. 1).

In Mexico, human disturbance continues to pose a significant threat to the California least tern because there are fewer regulatory mechanisms and fewer barriers to restrict nesting site access, including vehicle access (Palacios Castro 2008, pers. comm.; Sin et al. 2019, unpaginated). Without barriers, California least terns nesting at Punta Banda in 1995 established nests at an alternative mudflat site, presumably because their preferred nesting site was being used by tourists and pets for camping and playing golf (Zuria and Mellink 2002, p. 619). The alternative nesting location was later disturbed by all-terrain vehicles and horses, which led to some eggs being crushed, some eggs being collected by visitors, and some nests being abandoned (Zuria and Mellink 2002, p. 620).

In addition to direct disturbance and mortality, certain human disturbances also degrade California least tern habitat. Vehicle use and beach grooming removes seaweed, surf-cast materials, and plants that provide sheltering habitat for nests and chicks. These activities also degrade nesting and sheltering habitat by flattening the surface and removing nest scrapes,

hummocks, and dunes. Other activities also impact nesting and foraging habitat through pollution. Motorboating creates air and water pollution and setting off fireworks displays contaminates air and water with perchlorate, particulate matter, and metals (Croteau et al. 2010, pp. 3297–3298; Sijimol and Mohan 2014, pp. 7203, 7205–7206). Motorboating also increases water turbidity (cloudiness caused by suspended particles in the water column) and wake that can harm sensitive aquatic plants like eelgrass, degrade foraging habitat and conditions, and erode nesting sites that border the water.

Dredging and beach nourishment (i.e., deposition of dredged sediment and sand at beaches) are common maintenance activities that occur in some California least tern breeding and foraging habitats. In addition to direct disturbance through heavy equipment operation and occasional nighttime lighting, dredging and beach nourishment can degrade California least tern habitat. High levels of water turbidity and subsequent sedimentation, such as those caused by dredging and beach nourishment, may affect productivity of phytoplankton, photosynthesis in macrophytes, benthic invertebrates, fish, and the foraging success of California least terns (Burton and Terrill 2012, p. 24). A reduction in foraging success could be caused either by reduced visibility of prey within the turbidity plume or by reductions in prey fish abundance. In either case, California least terns would need to expend increased time and energy as they are forced to forage for longer periods of time in poorer quality habitat and/or fly greater distances to find and use new foraging sites. While California least terns may experience a decreased ability to visibly detect prey in turbid water, there is also some evidence that increased turbidity can alter the behavior of fish, making them easier to find and capture by avian predators (Keane and Smith 2016, p. 21). The relationship between water clarity and foraging success by terns has been studied to some extent but with mixed conclusions (Burton and Terrill 2012, pp. 24–25). Beach nourishment can also degrade California least tern nesting and sheltering habitat by burying nest scrapes, surf-cast materials, and plants that provide sheltering habitat for nests and chicks. However, beach nourishment can also create or help maintain nesting habitat that is subject to erosion. The greatest impacts of dredging and beach nourishment to California least tern habitat are likely ecosystem disruption (from removal of materials, deepening the water channel, and turbidity) leading to poorer prey abundance and potential re-suspension or deposition of toxic contaminants (from dredged sediment) that could re-enter the food web (Burton and Terrill 2012, pp. 25, 35–36; Wenger et al. 2017, entire).

Table 6. Human activities that have impacts to California least tern.

Human Activity	Impact
Pedestrians and equestrians camping, recreating, or walking in or around nesting areas (both legally and trespassing in fenced areas); vandalism of nest markers, signs, and/or research equipment	Trampling of eggs and chicks; Noise and visual disturbance that alters foraging, breeding, and sheltering behaviors; Flushing of adults and fledglings (resulting in stress and increased resource use, decreased nest attendance and feeding of young, and potentially attracting predators); Disturbance in or near nesting site may result in nest or nesting site abandonment; Attraction of predators by deposition of trash/garbage

Human Activity	Impact
Walking dogs in or around nesting areas (both legally and trespassing in fenced areas)	Trampling, or predation of eggs and chicks; Noise and visual disturbance, as well as presence of a predator, alters foraging, breeding, and sheltering behaviors; Pursuit and flushing of adult, fledglings, and chicks (resulting in stress and increased resource use, decreased nest attendance and feeding of young, and potentially attracting other predators); Disturbance in or near nesting site may result in nest or nesting site abandonment
Vehicle use, beach grooming, and off-highway vehicle recreation in or around nesting areas	Crushing of all life stages; Noise and visual disturbance that alters foraging, breeding, and sheltering behaviors; Flushing of adults and fledglings (resulting in stress and increased resource use, decreased nest attendance and feeding of young, and potentially attracting predators); Disturbance in or near nesting site may result in nest or nesting site abandonment; Degradation of nesting habitat
Low flying aircraft (helicopters and planes)	Noise and visual disturbance that alters foraging, breeding, and sheltering behaviors; Flushing of adults and fledglings (resulting in stress and increased resource use, decreased nest attendance and feeding of young, and potentially attracting predators)
Train passage	Noise disturbance (including honking horn) and vibration that alters feeding, breeding, and sheltering behaviors; Flushing of adults and fledglings (resulting in stress and increased resource use, decreased nest attendance and feeding of young, and potentially attracting predators); Increased risk of predation because train track structures provide perches for avian predators (Service 2022, p. 26)
Motorboating	Noise and visual disturbance that alters foraging, breeding, and sheltering behaviors; Flushing of adults and fledglings (resulting in stress and increased resource use, decreased nest attendance and feeding of young, and potentially attracting predators); Prolonged elevated noise levels may affect ability to detect approaching predators, mask alarm calls, and disrupt general communication; Degradation of nesting and foraging habitat
Fireworks	Noise and light disturbance that severely alters foraging, breeding, and sheltering behaviors; Flushing of adults and fledglings (resulting in stress and increased resource use, decreased nest attendance and feeding of young, and potentially attracting predators); In panic, chicks may trample each other, become trapped in vegetation, or flush into the water or other unsafe areas; Prolonged elevated noise levels may affect ability

Human Activity	Impact
	to detect approaching predators, mask alarm calls, and disrupt general communication; Degradation of nesting and foraging habitat
Recreation events	Noise and visual disturbance that alters foraging, breeding, and sheltering behaviors; Flushing of adults and fledglings (resulting in stress and increased resource use, decreased nest attendance and feeding of young, and potentially attracting predators); Increase occurrence of trespass into nesting areas that may result in trampling of eggs and chicks; Prolonged elevated noise levels may affect ability to detect approaching predators, mask alarm calls, and disrupt general communication; Disturbance in or near nesting site may result in nest or nesting site abandonment
Military training and operations	Noise and visual disturbance that alters foraging, breeding, and sheltering behaviors; Flushing of adults and fledglings (resulting in stress and increased resource use, decreased nest attendance and feeding of young, and potentially attracting predators); Disturbance in or near nesting site may result in nest or nesting site abandonment; May result in trampling of eggs and chicks; Avoidance and minimization measures reduce the impact of military training exercises
Dredging and beach nourishment (removal and deposition of sediment in or near nesting or foraging habitat using heavy machinery)	Noise, visual, vibration, and possibly light disturbance that alters foraging, breeding, and sheltering behaviors; Prolonged elevated noise levels may affect ability to detect approaching predators, mask alarm calls, and disrupt general communication; Disturbance in or near nesting site may result in nest or nesting site abandonment; Degradation of nesting and foraging habitat
Release of captured predators (e.g., cats, raccoons, etc.) near nesting sites	Predation of all life stages; Increased presence of predators alters foraging, breeding, and sheltering behaviors
Operation of drones over nesting areas	Noise and visual disturbance that alters foraging, breeding, and sheltering behaviors; Flushing of adults and fledglings (resulting in stress and increased resource use, decreased nest attendance and feeding of young, and potentially attracting predators); A drone landed in Mariner’s Point (Mission Bay), which then led the drone owner to attempt to trespass in a dense nesting site to retrieve the drone (Santa Maria 2024, pers. comm.)

Human disturbance management

A combination of fencing and visitor education is used at California least tern nesting sites to reduce the threat of human disturbance. Of the 59 nesting sites in California monitored in 2019 (some nesting areas contain multiple nesting sites), 42 percent have a complete fence or barrier that excludes humans and most predators, and 25 percent have some type of barrier (either literal or symbolic) to minimize human access to nesting sites and reduce impacts to terns (Sin et al. 2024, pp. 33–38, appendix 1B). The nesting sites near areas with high levels of recreational use, such as Venice Beach and Huntington State Beach, are completely fenced to reduce human encroachment. Symbolic barriers do not exclude human encroachment into the nesting sites but do provide a visible deterrent. Outreach programs can help educate the public on the role of fencing and the importance of undisturbed areas for nesting birds. Visitors that receive education on conservation issues are more likely to act in environmentally responsible ways (Orams 1997, p. 304). For California least terns, efforts to educate and direct the public, such as posting signs and fencing at access points, has helped reduce (but not eliminate) the threat of disturbance to nesting sites (Patton 2009, p. 11). Approximately 38 of the 59 nesting sites (65 percent) monitored in California in 2019 had interpretive education signs (Sin et al. 2024, pp. 33–38, appendix 1B).

In Mexico, fencing has been used in some cases to reduce human disturbance (especially regular off-road vehicle activity for which there is no enforcement); however, fencing is often stolen for personal use (Palacios Castro 2008, pers. comm.). An organization in Mexico, Pro Esteros, has recently reduced the threat of human disturbance at the northernmost California least tern nesting area in Mexico (Ortiz 2024, pers. comm.; Ortiz 2025, pers. comm.). At Punta Banda (near Ensenada, Mexico), Pro Esteros (with funding from CDFW) has been installing interpretive signs and a temporary rope barrier (a rope strung between fence posts to deter pedestrians and prevent vehicles from driving through nesting sites) around the nesting site since 2018 (Ortiz 2024, pers. comm.; Ortiz 2025, pers. comm.). Pro Esteros also does environmental education by engaging the local community in site clean-up and preparation and by celebrating a least tern day in the community (Ortiz 2024, pers. comm.; Ortiz 2025, pers. comm.). The effectiveness of these measures has not yet been determined.

While management of human disturbance at nesting sites through fencing, signage, and education lowers impacts, these measures do not entirely remove the threat of direct mortality at managed sites. Despite deterrents, trespass in fenced areas still occurs, even when areas are completely enclosed and well-marked (Jackson 2025, p. 5). In addition, fencing does not encompass all available nesting habitat, leading to mortalities outside of enclosure fences (California Coastal Commission 2021, p. 17). For example, while most of the nesting areas at Oceano Dunes State Vehicular Recreation Area are seasonally fenced to exclude off-highway vehicles, vehicles are still causing California least tern mortalities in violation of the federal and California Endangered Species Acts (California Coastal Commission 2021, pp. 6, 17). In addition, the presence of dogs, horses, vehicles, and recreators outside of fenced areas still causes noise disturbance, visual disturbance, and trash that attracts predators. There is often no buffer between nesting sites and adjacent, intensive human uses, so activities adjacent to nesting sites continue to impact California least tern feeding, breeding, and sheltering behaviors.

We expect human disturbance to continue increasing at California least tern nesting sites in the future. This is in part due to trends of increasing human population and development in Baja California, Mexico (Safran et al. 2017, pp. 62–63). Another factor is increased human use of coastal beaches in California associated with climate extremes. Changing climate conditions in California, such as higher maximum temperatures, are likely to increase recreation demand in coastal regions (Manley and Egoh 2022, pp. 5–6, 9). Extreme drought conditions during 2001–2020 were associated with an approximate 15 percent increase in the number of day use visitors to state beaches from San Luis Obispo to San Diego County (Jenkins et al. 2025, p. 7). These effects may also be exacerbated by sea level rise and coastal erosion, which will decrease the area available for shared human and wildlife use.

Summary

Human disturbance is a moderate- to high-magnitude threat in the United States that can cause direct mortality through crushing of eggs and young as well as cause detrimental effects on nesting behavior. Active management, conservation measures, and fencing of nesting sites have reduced the impacts from this threat in the United States since listing, but we expect human disturbance to increase in the future. While human disturbance negatively influences California least tern productivity at many sites, it is not likely that this threat has been the driver of the population decline that began in 2010. In Mexico, human disturbance is still a primary and increasing threat (high magnitude) at nesting sites. Increased management and expansion of efforts in Mexico (especially if coastal development and tourism continues to increase) are needed to prevent human disturbance from contributing to the decline of the California least tern in the future.

Climate Change

Increasing temperature at nesting sites

Climate change was discussed as a threat in the 2020 5-year review, primarily related to sea level rise and the influence of increased sea surface temperatures on food availability. In addition to a warmer ocean's negative effect on food availability, increasing temperature at nesting sites may also negatively affect the survival of California least tern eggs and chicks due to heat stress or changes in adult behavior. Shorebirds, including interior least terns (*Sternula antillarum athalassos*), alter nesting behavior in response to rising temperatures (Andes et al. 2020, entire). Interior least terns exhibited decreased daily nest attendance with a corresponding increase in temperature and increased nest shading behavior when sand exceeded a mean daily temperature of 77 degrees (°) Fahrenheit (25° Celsius) (Andes et al. 2020, p. 7).

While studies have not yet determined the influence of high temperatures on California least tern egg and chick survival, field biologists recognize the risks of heat stress at nesting sites (Jackson 2025, p. 2) and avoid monitoring sites when air temperatures 2.8 inches (7 centimeters) above the substrate exceed 84° Fahrenheit (29° Celsius) (e.g., Wooten et al. 2023, p. 13). In a preliminary substrate temperature study, the temperature of soil substrate at the Mission Bay FAA (Federal Avian Administration) Island nesting site reached over 104° Fahrenheit (40° Celsius) during 2024 (a “relatively cool season”) (Jackson 2025, p. 10). Substrates of sand, shell, and oyster remained cooler than silt substrate and soil substrate, which was the hottest (Jackson

2025, p. 18, Figure 4). Chick shelters, as described under the subheading Predator management, are provided at 33 of the 59 nesting sites (56 percent) in California (Sin et al. 2024, pp. 33–38, appendix 1B) for both predator protection and for shade. Restoration of nesting sites with cooler substrates and increased use of chick shelters may reduce the threat of increasing temperatures.

Cal-Adapt models project that annual average maximum temperatures at California least tern nesting sites in California will continue to increase (Table 7; Pierce et al. 2018, entire). Averaged across the five California regions (Table 7), annual average maximum temperatures are projected to increase by 4.7° Fahrenheit (2.6° Celsius) under the Representative Concentration Pathway (RCP) 4.5 emissions scenario, and by 7.4° Fahrenheit (4.1° Celsius) under the RCP8.5 emissions scenario by the end of the century (2070–2099) (Cal-Adapt 2018, dataset). Projections of increases in annual average maximum temperatures are similar across nesting site regions in California; however, maximum temperatures are projected to increase the most at nesting sites in the Los Angeles and Orange counties region (Table 7). More information about the Cal-Adapt projections, including figures of the projections, are provided in Appendix B: Maximum Temperature Projections.

Table 7. Projected annual average maximum temperatures for five regional groups of California least tern nesting sites in California. The values are the average of projections from four priority models (i.e., MIROC5, CanESM2, HadGEM2-ES, and CNRM-CM5) for the historical (1961–1990), mid-century (2035–2064), and end-of-century (2070–2099) time periods. Average projections are provided for two emissions scenarios, Representative Concentration Pathway (RCP) 4.5 and RCP8.5. Units are in degrees Fahrenheit. Data are sourced from Cal-Adapt (2018, dataset; Pierce et al. 2018, entire).

Region (Scenario)	Historical Baseline 1961–1990 (modeled)	Mid-century 2035–2064	End of Century 2070–2099
San Francisco Bay area nesting sites (RCP4.5)	69.9 (range: 67.0–72.5)	73.4 (range: 70.5–76.2)	74.7 (range: 71.9–77.7)
San Francisco Bay area nesting sites (RCP8.5)	69.9 (range: 67.0–72.5)	74.3 (range: 70.9–78.2)	77.5 (range: 73.6–82.0)
San Luis Obispo and Santa Barbara county nesting sites (RCP4.5)	70.0 (range: 66.7–73.2)	73.4 (range: 70.4–76.8)	74.6 (range: 71.3–78.5)
San Luis Obispo and Santa Barbara county nesting sites (RCP8.5)	70.0 (range: 66.7–73.2)	74.2 (range: 71.3–77.9)	77.1 (range: 73.9–81.4)
Ventura County nesting sites (RCP4.5)	71.8 (range: 69.1–74.6)	75.3 (range: 72.4–78.2)	76.5 (range: 70.4–79.6)
Ventura County nesting sites (RCP8.5)	71.8 (range: 69.1–74.6)	76.1 (range: 73.5–79.5)	78.9 (range: 75.2–82.7)
Los Angeles and Orange county nesting sites (RCP4.5)	72.5 (range: 69.9–75.2)	76.2 (range: 73.5–79.5)	77.5 (range: 75.0–80.6)
Los Angeles and Orange county nesting sites (RCP8.5)	72.5 (range: 69.9–75.2)	77.1 (range: 74.3–80.7)	80.2 (range: 76.5–84.5)
San Diego County nesting sites (RCP4.5)	71.2 (range: 69.1–73.8)	74.6 (range: 72.0–77.5)	75.8 (range: 73.1–79.3)
San Diego County nesting sites (RCP8.5)	71.2 (range: 69.1–73.8)	75.5 (range: 72.8–79.3)	78.6 (range: 75.1–82.5)

In summary, the magnitude of the threat of increasing temperature at nesting sites is currently low in both the United States and Mexico based on lack of heat-related mortalities. However, temperatures are projected to continue increasing. Therefore, the magnitude of this threat is likely to increase in the future.

Sea level rise and limited ability for managed retreat

Global sea level rise due to climate change poses a threat to California least tern nesting habitat. Most nesting areas are found on low-lying areas along estuaries or ocean beaches. While some nesting sites will likely be partially or fully inundated in the future, rising seas levels already affect some nesting sites through periodic flooding during high tides or king tides (exceptionally high tides). If flooding occurs during nesting, eggs exposed to sea water become nonviable and chicks may be washed away. Flooding may cause site failure for that year. One of the sites at the Marine Corps Base Camp Pendleton nesting area (White Beach Central) has failed repeatedly from flooding during regular high tides although it is preferred nesting habitat (Wooten et al. 2023, p. 36). Eggs and nests are periodically lost to flooding at several nesting areas including Santa Clara River/McGrath State Beach, Point Mugu, Malibu Lagoon, Seal Beach National Wildlife Refuge/Anaheim Bay, Marine Corps Base Camp Pendleton, and Tijuana Estuary National Estuarine Research Reserve (Sin et al. 2024, pp. 65–72, Appendix 7a–7b). In 2020, the fence around the nesting site at Huntington State Beach was moved inland by 10 meters because of erosion associated with sea level rise (Zembal et al. 2025, p. 2).

In Mexico, flooding of nest sites is also known to cause nest failure (Amador et al. 2008, p. 272; Palacios Castro 2008, pers. comm.; Ortiz 2025, pers. comm.). At Punta Banda (the northernmost nesting area in Mexico), king tides are considered a significant threat to California least tern because they flood the nesting sites during some years (Ortiz 2025, pers. comm.).

Managed retreat (i.e., strategically relocating or shifting nesting sites to areas less prone to flooding and sea level rise) is being considered for some California least tern nesting sites. For example, Ormond Beach has planned a habitat restoration (Coastal Conservancy 2024, entire) that will expand available habitat for nesting California least terns and buffer the site from the effects of sea level rise. While managed retreat is an available option at some nesting sites, there is limited ability for retreat at many sites because of their proximity to existing development.

According to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), global mean sea level increased by 1.3 mm/yr between 1901 and 1971, 1.9 mm/yr between 1971 and 2006, and 3.7 mm/yr between 2006 and 2018 (IPCC 2023, p. 5). Further global sea level rise is virtually certain and there is high confidence that current 1-in-100-year extreme sea level events would occur at least annually in more than half of all tide gauge locations by 2100 under all considered scenarios (IPCC 2023, pp. 13, 77). The IPCC explains that long-term future sea level rise is unavoidable (regardless of emissions) due to continuing deep ocean warming and ice sheet melt, and sea levels will remain elevated for thousands of years (IPCC 2023, p. 77).

Based on the best available information for coastal planning in California, sea levels are expected to rise 0.8 feet (ft) by 2050 and 1.6–3.1 ft (or higher) by 2100, relative to a 2000 baseline (California Sea Level Rise Guidance 2024, pp. 7–8). These sea level rise projections are relevant for all tidally influenced areas of the California shoreline including all of California's outer coast and parts of the Sacramento-San Joaquin River Delta (California Sea Level Rise Guidance 2024, p. 13).

The previous 5-year review assessed how a 1-ft and 3-ft sea level rise would impact current California least tern nesting areas in California (Service 2020, pp. 33–37). Table 8 and Table 9 (from the analysis in the 2020 5-year review) summarize probable inundation of California least tern nesting habitat with 1 ft and 3 ft of sea level rise, respectively. With 1 ft of sea level rise, which is considered likely by 2050–2060, approximately 47 percent of current nesting habitat in California would be impacted (Table 8). With 3 ft of sea level rise, which is considered the upper range of most likely in 2100, approximately 65 percent of current nesting habitat in California would be impacted and 3 sites would be completely inundated (Table 9). For more information on this sea level rise analysis and for individual site-specific projections for sea level rise scenarios of 1, 2, 3, 4, and 5 ft, see Appendix C: Sea Level Rise Analysis.

In summary, sea level rise is currently a low-to-moderate magnitude threat to several nesting areas in both the United States and in Mexico. Based on the best available sea level rise projections, this threat will increase into the future, gradually affecting more and more nesting sites and habitat over time.

Table 8. Summary of impacts to California least tern nesting sites in the United States at 1-foot sea level rise, which is considered likely in 2050–2060 according to California Sea Level Rise Guidance (2024, pp. 6–8).

Probable Inundation	Number of nesting sites	Total acres at sites	Percent of total CLT habitat (1,204 ac)
None (< 1%)	24	643	53.4%
Minimal (1–20%)	7	248	20.6%
Moderate (21–50%)	5	132	10.9%
Significant (51–99%)	2	178	14.8%
Complete (100%)	2	< 1	0.1%

Table 9. Summary of impacts to California least tern nesting sites in the United States at 3-foot sea level rise, which is considered the upper range of most likely in 2100 according to California Sea Level Rise Guidance (2024, pp. 7–8).

Probable Inundation	Number of nesting sites	Total acres at sites	Percent of total CLT habitat (1,204 ac)
None (< 1%)	18	418	34.7%
Minimal (1–20%)	10	358	29.8%
Moderate (21–50%)	5	131	10.9%
Significant (51–99%)	4	117	9.7%
Complete (100%)	3	177	14.7%

Environmental Contaminants and Toxins

As described in the 2020 5-year review, contaminants such as DDT (dichlorodiphenyltrichloroethane), selenium, oil, and mercury have historically been identified in nesting areas throughout the range of California least terns. Boardman (1988, pp. 9–10, Tables 2–3) detected DDT and its metabolites in California least tern eggs and liver samples from adult birds and nesting sites throughout southern California in the 1980s (e.g., Bolsa Chica Ecological Reserve, Marine Corps Base Camp Pendleton, San Diego Bay, Terminal Island). High levels of pesticides and heavy metals are known to cause reproductive harm in breeding birds (Longcore et al. 1971, p. 486; King et al. 1978, p. 17). The organochlorine pesticide DDT breaks down in the environment to form DDE (dichlorodiphenyldichloroethylene), a compound that causes thinning of eggshells and decreased reproductive success in many species of birds (Longcore et al. 1971, pp. 486, 489). Selenium is a naturally occurring element that may also act as a contaminant and affect birds under certain conditions. At low levels, selenium is an essential trace nutrient that serves multiple metabolic functions in animals (Arthur and Beckett 1994, p. 620), but at higher concentrations it can cause embryo malformation and death (Hoffman et al. 1988, p. 521). Mercury causes both decreased fledgling success and decreased parental care in waterbirds (Evers et al. 2008, pp. 74–75).

Birds are exposed to contaminants and toxins mainly through the food they eat. For substances that bioaccumulate, like DDT and mercury, fish-eating birds are exposed to higher dietary concentrations and accumulate higher levels of contaminants in their tissues than birds that feed on seeds or invertebrates (Frank et al. 1975, p. 214; Focardi et al. 1988, p. 253; Ruelas-Inzunza et al. 2009, p. 418). For example, past studies have linked reproductive failure with heightened pesticide levels in the common tern (*Sterna hirundo*) and the roseate tern (*Sterna dougallii*), both fish-eating species (Hays and Risebrough 1972, p. 21; Fox 1976, p. 470), but these effects were less pronounced in the black tern (*Chlidonias niger*), which is primarily insectivorous (Frank et al. 1975, pp. 211, 214). Therefore, the California least tern may be at more risk of exposure and subsequent contaminant-related impacts than many other bird species because of their diet. However, contaminant concentrations (except perhaps for mercury) are generally lower in California least terns compared to larger-bodied fish-eating seabirds (Clatterbuck et al. 2018, p. 460).

A variety of contaminants that can negatively affect seabirds are still found throughout the breeding range of the California least tern in California, especially in bays and lagoons, and in areas associated with urban and agricultural runoff (Ackerman et al. 2016, entire; Bay et al. 2016, entire; Clatterbuck et al. 2018, entire; Service 2020, pp. 57–59). Although contaminants (polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers, DDTs, chlordanes, mercury, selenium, and arsenic) were detected in California least tern and other seabird eggs from Point Mugu to Tijuana Estuary National Estuarine Research Reserve, concentrations were below those known to cause adverse effects and are steady or declining compared to previous studies (Clatterbuck et al. 2018, pp. 460–467).

Least tern nesting sites in San Diego Bay are closely monitored for productivity, and no widespread nest failure due to eggshell cracking (caused by DDE) or embryo mortality (caused by PCBs) has been reported. Therefore, though DDE and PCBs are present in San Diego Bay, the best available scientific information does not show that these contaminants are resulting in adverse effects on California least terns.

Toxins that enter the food chain from harmful algal blooms, which was not discussed in previous 5-year reviews, could be another concern for California least terns. Harmful algal blooms are associated with increased ocean surface temperatures and nutrient run-off (Paerl and Huisman 2008, pp. 57–58; IPCC 2019, p. 16). These blooms have increased in distribution and frequency in coastal areas since the 1980s in response to both climatic and non-climatic drivers (IPCC 2019, p. 16). Harmful algal blooms produce the neurotoxins domoic acid and saxitoxin, which have coincided with seabird mortality events in the United States, including central/southern California (Nisbet 1983, entire; Gobble et al. 2021, pp. 1, 4–7). Gobble et al. (2021, pp. 3, 6–8) opportunistically tested dead seabirds collected during toxic algal blooms along the Pacific coast during 2007–2018 and found potentially lethal concentrations of domoic acid that was presumably ingested through consumption of northern anchovy (*Engraulis mordax*) or other prey. Consumption of prey with high levels of saxitoxin has also been linked the sudden death of 76 terns breeding in Massachusetts (Nisbet 1983, pp. 338–340, 343). It is uncertain if algal toxins are affecting California least terns but some chicks at Huntington State Beach were observed presenting neurological symptoms during a period with nearby harmful algal blooms (Ibarguchi 2020, p. 6). Site monitors at Huntington State Beach suggested that domoic acid could have played a role in lower California least tern productivity during 2011 and 2020 (Zembel et al. 2025, p. 11), but this has not been confirmed.

California least tern populations could also be negatively impacted by oil spills from offshore oil platforms or marine tankers. Oil spills from various known and unknown sources have caused seabird mortalities along the southern and central California coast for decades (Carter 2003, entire). Oiled birds lose their ability to regulate their body temperature because of loss of feather waterproofing and insulation, increasing risk of hypothermia; oiled birds may also have limited ability to fly or float, making it difficult to obtain food or evade predators (Ober 2019, p. 3). Birds are also harmed by inhaling and ingesting oil while preening (to clean themselves) or by feeding on contaminated prey (Ober 2019, pp. 1–3). Smaller spills (from pipelines, operations at onshore facilities, and tanker truck accidents) in areas adjacent to nesting or foraging habitat could also affect California least terns by polluting food resources.

The magnitude of the impact of oil spills on the California least tern’s status in the future is dependent on how often the spills might occur. The former Mineral Management Services calculated the risk of spills occurring from offshore oil activities, including drilling platforms and pipelines. They found that there is a 41.2 percent chance of a spill occurring due to Federal offshore oil drilling and pipelines and an 8.4 percent chance of an oil spill occurring from state lands in the next 28 years (McCrary et al. 2003, pp. 45–46).

Oil spills have previously occurred in proximity to California least tern nesting areas, but they have not occurred during the California least tern breeding season (Service 2020, pp. 58–59). In the past 10 years, two large oil spills have affected California least tern breeding habitat. On May 19, 2015, an on-shore pipeline along the Santa Barbara County coastline ruptured and released approximately 2,934 barrels (123,228 gallons) of heavy crude oil that ultimately discharged into the Pacific Ocean at Refugio State Beach (Refugio Beach Oil Spill Trustees 2021, p. 4). As a result, tar balls eventually reached some beaches as far as Los Angeles County and oil as far as Seal Beach in Orange County; however, California least terns are not thought to have been directly affected (Refugio Beach Oil Spill Trustees 2021, pp. 4, 20, 37). On October 1, 2021, an underwater pipeline ruptured spilling a minimum of approximately 24,696 gallons of crude oil into San Pedro Bay (NOAA 2023, p. 39407). Southern California beaches from at least Surfside

Beach to potentially past the United States/Mexico Border, including coastal marshes and lagoons, were either freshly oiled or received varying levels of tar balls in the weeks following the spill (NOAA 2023, p. 39407). Fortunately, California least terns were not directly affected because of timing.

California least terns may face greater exposure to contaminants in Mexico than in the United States. Although DDT was banned in the United States in the 1970s, it was used for malaria control in Mexico until the early 1990s (García-Hernández et al. 2006, p. 1640). Coastal lagoons in Mexico have widely varying levels of pesticides (Páez-Osuna et al. 2002, p. 1305), but specific data for areas where least terns nest in Mexico are unavailable. In addition, there are no data on DDT concentrations in least tern eggs or in forage fish where least terns nest in Mexico.

In summary, contaminants and toxins have the potential to pose a threat to California least terns. However, though moderate or high levels of contaminants are present in several high-density least tern nesting areas (such as sites around San Francisco Bay and San Diego Bay), there are no conclusive data documenting mortality or reproductive harm from contaminants in California least terns. Oil spills have the potential to have detrimental impacts on nesting California least terns. However, the impact would likely be limited to one or two breeding seasons. Furthermore, the Service is an active participant in the southern California area contingency planning efforts and our pre-planning efforts serve to avoid and minimize impacts from both spills and response actions. Therefore, though oil spills have the potential to pose a threat to California least terns in the future, the magnitude of this threat is low. Overall, we do not expect contaminants to pose a significant threat to the continued existence of the California least tern throughout its range now or in the future.

Disease

Disease has been discussed as a potential threat to California least terns in previous status reviews (Service 2014, p. 27; Service 2020, pp. 38–39). Colonial nesting waterbirds with similar life history traits to the California least tern are known to be subject to disease outbreaks (Brand et al. 1983, p. 269; Friend 2002, p. 293). The flocking nature of tern species, exacerbated by loss of habitat and the concentration of large numbers of least terns at just a few nesting sites, may increase their vulnerability to disease and mass die offs. In the Laridae family (includes gulls, terns, noddies, and skimmers), the most commonly reported cases of disease are from avian botulism (38 percent), followed by salmonellosis (10 percent of all recorded microbial events), aspergillosis (9 percent), avian cholera (9 percent), Newcastle disease (5 percent) and ornithosis (5 percent) (Hubálek 2021, p. 1). West Nile virus disease, haemosporidiosis, avian influenza, avian tuberculosis, toxoplasmosis, coccidiosis, avian pox, tick-borne virus diseases, circovirus infection, avian papilloma, erysipelas, candidosis, staphylococcosis, sarcosporidiosis, cryptosporidiosis, necrotic clostridial enteritis, colibacillosis, babesiosis, calicivirus and avian bornavirus infections account for less than 5 percent of Laridae morbidity and mortality events (Hubálek 2021, p. 1).

Disease-related die-off events have not been documented in the California least tern. We are aware of one die-off event in the eastern least tern subspecies (*Sternula antillarum antillarum*). In 1967, the eastern least tern was 1 of 12 bird species affected in an avian botulism die off of approximately 1,000 birds in a New Jersey tidal estuary (Reilly and Boroff 1967, p. 26). The

least terns were infected with the botulism toxin through consumption of infected killifish (*Fundulus heteroclitus*) (Reilly and Boroff 1967, entire).

A potential concern is the recent emergence of highly pathogenic avian influenza (HPAI) in the range of the California least tern. HPAI has been detected in several co-occurring species in the range of California least tern (e.g., American white pelican (*Pelecanus erythrorhynchos*), western gull (*Larus occidentalis*), etc.). However, HPAI has not been detected in any tern species in the state of California since the outbreak began in 2022 (USDA APHIS 2025, unpaginated).

While disease does not seem to be affecting California least terns on a large scale, it may still be affecting some individuals periodically. The 2020 5-year review described several necropsies where viruses or bacteria (including West Nile Virus, *Vibrio cholera*, *Escherichia coli*, and *Streptococcus*) were identified as likely causes of individual California least tern deaths or where bacterial pathogens were detected in chick and adult carcasses (Service 2020, pp. 38–39). Though few specimens are regularly analyzed, we have not seen evidence of large-scale impacts of disease on any tern populations in California or in other parts of the United States. Given the lack of evidence of significant impacts, and the low number of deaths attributable to viral and bacterial pathogens, disease is not considered a significant threat to the California least tern.

We do not have information about disease affecting California least terns breeding in Mexico. However, the magnitude of the threat of disease is unlikely to differ significantly across its breeding range. If anything, the threat of disease may be lower in Mexico because nesting sites tend to be smaller, thus reducing the risk of disease transmission.

In summary, the magnitude of the threat of disease is low based on lack of disease-related die-offs in this subspecies. While the threat of disease may change in the future, we do not currently have information to suggest that it will increase significantly.

Summary of Threats

The California least tern is affected by several threats of varying magnitudes (Table 10). The status of these threats has changed little since the 2020 5-year review, but research and monitoring has continued to deepen our understanding of how these threats are currently affecting, and will continue to affect, the subspecies in the future. The best available information suggests that reduced food availability and predation are leading drivers of the declines in breeding pairs and fledging success observed over the past several years; and these threats are potentially increasing. Development and habitat modification due to encroaching vegetation are now managed in the United States such that they are low-to-moderate magnitude threats that are potentially likely to increase in Mexico. Human disturbance, while managed in the United States, remains a moderate- to high-magnitude threat and is a high-magnitude threat at many nesting sites in Mexico. Increasing temperature at nesting sites has yet to show noticeable effects on survival of eggs and chicks, but this threat will increase in the future as temperatures continue to increase. Sea level rise is periodically affecting low-lying nesting sites across the subspecies' range and will continue to increase as a threat in the future. Environmental contaminants and toxins and disease are low-magnitude threats that may be affecting California least terns at sublethal levels.

Table 10. Summary of threat magnitude and trend to breeding California least terns in the United States and Mexico.

Threat	Threat magnitude and trend in the United States	Threat magnitude and trend in Mexico
Development	Magnitude: low-to-moderate Trend: relatively stable	Magnitude: low-to-moderate Trend: increasing
Reduced food availability	Magnitude: moderate-to-high Trend: potentially increasing	Magnitude: moderate-to-high Trend: potentially increasing
Predation	Magnitude: high Trend: potentially increasing	Magnitude: high Trend: likely increasing with development
Habitat modification due to encroaching vegetation	Magnitude: low-to-moderate because of management Trend: stable with continued management	Magnitude: low Trend: potentially increasing with development and sea level rise
Human disturbance	Magnitude: moderate-to-high Trend: potentially increasing with increasing coastal recreation	Magnitude: high Trend: potentially increasing with development
Increasing temperature at nesting sites	Magnitude: low Trend: increasing	Magnitude: low Trend: increasing
Sea level rise	Magnitude: low-to-moderate Trend: increasing	Magnitude: low-to-moderate Trend: increasing
Environmental contaminants and toxins	Magnitude: low Trend: stable	Magnitude: low Trend: stable
Disease	Magnitude: low Trend: stable	Magnitude: low Trend: stable

CONCLUSION

The California least tern was federally listed as endangered in 1969 (Service 1969, p. 5034). While management has helped to improve the status of the California least tern since listing, increasing threats have led to a steady population decline over the past 15 years. Some threats, including human disturbance, vegetation encroachment, and predation, are actively managed at many nesting areas and have been reduced through implementation of management plans by volunteer, local, State, and Federal agencies. Despite these efforts, the population of California least terns has been in decline since it peaked in 2010 at an estimated 6,699 minimum breeding pairs in California (majority of population) (Figure 4). The most recent estimate of minimum breeding pairs in California was 2,716 in 2023. The best available information suggests that reduced food availability and predation are leading drivers of this decline and reduced fledging success observed over the past several years. Increases in management (especially improvements in habitat quality and predator management) are needed for the population of California least terns to rebound. Management actions have been effective at reducing impacts to the species and habitat but are likely to be needed long term to maintain suitable nesting habitat and reduce impacts from ongoing threats—particularly predation and human disturbance.

The majority of the breeding population and its reproductive metrics are well monitored. However, there are still uncertainties regarding the California least tern’s migration and nonbreeding ranges, and status at breeding sites in Mexico. While this 5-year review summarized new or updated information on the effects of reduced food availability and sea level rise on the California least tern, more research is needed to better understand these threats and how they can be managed in the future. Furthermore, a range-wide population viability analysis would be useful to inform revised recovery criteria.

In sum, the new information and updated occurrence status does not substantially alter the subspecies’ status or the results of our five-factor analysis in the 2020 5-year review. Therefore, we conclude that the California least tern remains a federally endangered subspecies and recommend no change in listing status.

New Recovery Priority Number and Brief Rationale: Change from 15C to 12C

As we concluded in our 2020 5-year review, the California least tern had a recovery priority number of 15C, which is defined as a subspecies that faces a low degree of threat and has a high recovery potential (Service 1983, p. 51985). The “C” indicates conflict with construction or other development projects, or other forms of economic activity. Upon completion of this 5-year review, we conclude that the recovery priority number should be changed. The subspecies currently has a moderate degree of threat and a low potential for recovery because of elevated predation pressures and reduced food availability. Furthermore, successful reproduction at many nesting areas is dependent on ongoing predator management, which sometimes has limited success. The threat of reduced food availability near nesting areas is still poorly understood and it is uncertain whether this threat can be managed or alleviated. Therefore, due to the reliance on ongoing management and difficulty in ameliorating threats, we are changing the recovery priority number from 15C to 12C.

RECOMMENDATIONS FOR FUTURE ACTIONS

Successful implementation of these recommended actions will aid in recovery of the California least tern. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future restoration efforts.

1. Continue to coordinate with CDFW, San Diego State University, and other partners to analyze existing California least tern data, to determine long-term trends; create population models that identify demographic requirements for a stable population; and direct future management priorities to determine population and nesting site stability.
2. Work with the DOD (Navy, Marine Corps, and Space Force), CDFW, California Department of Parks and Recreation, California Natural Resources Agency and other partners to continue current successful site management that minimizes impacts of encroaching vegetation, predation, and human disturbance. Investigate and implement innovative techniques of predator control and site management and monitoring to reduce costs and better protect the species.
3. Continue to streamline permitting necessary for effective management of native predators.
4. Set up long-term funding (e.g., endowment) to ensure continued management of habitat and threats into the future. Evaluate nesting site needs and long-term suitability to prioritize use of funding.
5. Continue to evaluate the impact that shifting food resources have on California least tern survival, productivity, and nesting site dynamics.
6. Partner with Mexican nongovernmental organizations, scientists, and Federal agencies on potential recovery and management actions at nesting sites in Mexico.
7. Continue and expand research efforts to identify the nonbreeding range and migratory connectivity of the California least tern and the threats that impact the species on its nonbreeding grounds and migration routes.
8. Research subspecies taxonomy using multiple lines of evidence (such as morphology, genetics, and movement ecology) to determine validity and distribution of least tern subspecies in Mexico and California.
9. Develop banding protocol to create unified range-wide data collection. Continue to expand banding and recapture efforts to determine age structure, survival, and movement.
10. Enter into long-term agreements that will assure continued protection and management of California least tern nesting sites.
11. Work with land managers and local communities on long-term solutions to systematically address human disturbance activities (e.g., dogs off leash).

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APPENDIX A: BREEDING METRICS AT CALIFORNIA NESTING AREAS

Appendix A includes information related to breeding metrics collected at California least tern nesting areas. These include the minimum estimated number of breeding pairs, minimum estimated number of fledglings, and the minimum estimated fledgling ratios.

Table A-1. Minimum estimated breeding pairs of California least terns at California nesting areas, 2019–2023 (CDFW 2025, dataset).

Nesting Area/Site	2019	2020	2021	2022	2023	Average
Alameda Point	240	227	287	402	169	265
Anaheim Lake					0	0
Batiquitos Lagoon Ecological Reserve	481	72	271	233	205	252
Bolsa Chica Ecological Reserve	90	59	110	118	90	93
Burriss Island	14	12	16	11	6	12
Eden's Landing Ecological Reserve	71	0	39	30	49	38
Hayward Regional Shoreline	44	90	87	54	88	73
Hollywood Beach	0	11	0	9	0	4
Huntington State Beach	452	232	333	333	255	321
LA Harbor	161	91	170	172	1	119
Malibu Lagoon	0	0	0	0	0	0
Marine Corps Base Camp Pendleton	62	194	421	365	425	293
Mission Bay Total	135	150	158	178	141	152
Montezuma Wetlands	9	22	13	2	21	13
Napa Sonoma Marsh Wildlife Area	2	1	0	28	25	11
Naval Base Ventura County Point Mugu	234	135	140	207	168	177
Oceano Dunes State Vehicular Recreation Area	31	43	41	39	40	39
Ormond Beach	80	15	16	23	15	30
Rancho Guadalupe Dunes Preserve	13	38	0	0	0	10
Chula Vista Wildlife Reserve	51	102	73	67	47	68
D-Street Fill Sweetwater Marsh National Wildlife Refuge	77	5	77	64	29	50.4
Naval Air Station North Island	3	3	0	0	0	1.2
Naval Amphibious Base Coronado	717	908	972	719	596	782.4
San Diego International Airport Lindbergh Field	13	5	5	9	8	8

Nesting Area/Site	2019	2020	2021	2022	2023	Average
South San Diego Bay Unit San Diego National Wildlife Refuge Saltworks	28	35	17	17	38	27
San Dieguito Lagoon Ecological Reserve				23	34	29
San Elijo Lagoon Ecological Reserve	0	0	0	0	0	0
San Pablo Bay National Wildlife Refuge			39	39	2	27
Santa Clara River McGrath State Beach	0	23	60	20	22	25
Seal Beach National Wildlife Refuge Anaheim Bay	1	6	9	36	62	23
Tijuana Estuary National Estuarine Research Reserve	97	144	138	114	144	127
Upper Newport Bay Ecological Reserve	20	15	4	0	3	8
Vandenberg Space Force Base	43	8	24	38	33	29
Venice Beach	0	24	33	1	0	12

Table A-2. Minimum estimated California least tern fledglings at California nesting areas, 2019–2023 (CDFW 2025, dataset).

Nesting Area/Site	2019	2020	2021	2022	2023	Average
Alameda Point	182	289	161	196	109	187
Anaheim Lake					0	0
Batiquitos Lagoon Ecological Reserve	22	49	32	18	77	40
Bolsa Chica Ecological Reserve	44	0	14	21	36	23
Burriss Island	2	3	7	0	0	2
Eden’s Landing Ecological Reserve	10	0	1	4	4	4
Hayward Regional Shoreline	44	134	58	66	127	86
Hollywood Beach	0	0	0	0	0	0
Huntington State Beach	81	3	19	80	32	43
LA Harbor	97	3	38	2	0	28
Malibu Lagoon	0	0	0	0	0	0

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Nesting Area/Site	2019	2020	2021	2022	2023	Average
Marine Corps Base Camp Pendleton	15	100	92	94	173	95
Mission Bay Total	37	68	88	50	44	57
Montezuma Wetlands	2	3	4	0	2	2
Napa Sonoma Marsh Wildlife Area	0	0	0	0	6	1
Naval Base Ventura County Point Mugu	64	14	43	13	51	37
Oceano Dunes State Vehicular Recreation Area	38	38	48	37	35	39
Ormond Beach	18	6	16	6	3	10
Rancho Guadalupe Dunes Preserve	4	6	0	0	0	2
Chula Vista Wildlife Reserve	2	16	1	2	5	5
DStreet Fill Sweetwater Marsh National Wildlife Refuge	12	0	8	0	4	5
Naval Air Station North Island	1	2	0	0	0	1
Naval Amphibious Base Coronado	21	31	81	21	90	49
San Diego International Airport Lindbergh Field	6	4	6	9	10	7
South San Diego Bay Unit San Diego National Wildlife Refuge Saltworks	1	2	3	2	7	3
San Dieguito Lagoon Ecological Reserve				19	16	18
San Elijo Lagoon Ecological Reserve	0	0	0	0	0	0
San Pablo Bay National Wildlife Refuge			17	3	0	7
Santa Clara River McGrath State Beach	0	3	35	0	2	8
Seal Beach National Wildlife Refuge Anaheim Bay	0	1	0	2	13	3
Tijuana Estuary National Estuarine Research Reserve	6	15	16	24	35	19
Upper Newport Bay Ecological Reserve	4	5	0	0	3	2
Vandenberg Space Force Base	21	6	8	23	17	15
Venice Beach	0	25	5	0	0	6

Table A 3. Minimum estimated California least tern fledgling ratios (i.e., minimum estimated fledglings divided by the maximum estimated breeding pairs) at California nesting areas, 2019–2023 (CDFW 2025, dataset).

Nesting Area/Site	2019	2020	2021	2022	2023	Average
Alameda Point	0.54	0.67	0.42	0.48	0.32	0.49
Anaheim Lake					0.00	0.00
Batiquitos Lagoon Ecological Reserve	0.04	0.35	0.11	0.07	0.35	0.19
Bolsa Chica Ecological Reserve	0.45	0.00	0.09	0.13	0.32	0.20
Burriss Island	0.12	0.23	0.44	0.00	0.00	0.16
Eden's Landing Ecological Reserve	0.08	0.00	0.02	0.09	0.05	0.05
Hayward Regional Shoreline	0.81	1.33	0.63	1.12	0.89	0.96
Hollywood Beach	0.00	0.00	0.00	0.00	0.00	0.00
Huntington State Beach	0.16	0.01	0.04	0.21	0.12	0.11
LA Harbor	0.53	0.02	0.20	0.01	0.00	0.15
Malibu Lagoon	0.00	0.00	0.00	0.00	0.00	0.00
Marine Corps Base Camp Pendleton	0.04	0.27	0.16	0.22	0.33	0.20
Mission Bay Total	0.20	0.40	0.45	0.26	0.29	0.32
Montezuma Wetlands	0.17	0.12	0.17	0.00	0.06	0.10
Napa Sonoma Marsh Wildlife Area	0.00	0.00	0.00	0.00	0.15	0.03
Naval Base Ventura County Point Mugu	0.23	0.07	0.29	0.05	0.29	0.19
Oceano Dunes State Vehicular Recreation Area	1.15	0.86	0.91	0.86	0.83	0.92
Ormond Beach	0.21	0.29	0.59	0.23	0.16	0.30
Rancho Guadalupe Dunes Preserve	0.24	0.11	0.00	0.00	0.00	0.07
Chula Vista Wildlife Reserve	0.04	0.15	0.01	0.03	0.09	0.06
D-Street Fill Sweetwater Marsh National Wildlife Refuge	0.14	0.00	0.09	0.00	0.11	0.07
Naval Air Station North Island	0.25	0.33	0.00	0.00	0.00	0.12
Naval Amphibious Base Coronado	0.03	0.03	0.08	0.03	0.14	0.06
San Diego International Airport Lindbergh Field	0.35	0.80	0.60	0.90	1.25	0.78
South San Diego Bay Unit San Diego National Wildlife Refuge Saltworks	0.03	0.05	0.10	0.08	0.17	0.09
San Dieguito Lagoon Ecological Reserve				0.83	0.34	0.58
San Elijo Lagoon Ecological Reserve	0.00	0.00	0.00	0.00	0.00	0.00
San Pablo Bay National Wildlife Refuge			0.22	0.04	0.00	0.08

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Nesting Area/Site	2019	2020	2021	2022	2023	Average
Santa Clara River McGrath State Beach	0.00	0.08	0.42	0.00	0.07	0.11
Seal Beach National Wildlife Refuge Anaheim Bay	0.00	0.09	0.00	0.05	0.20	0.07
Tijuana Estuary National Estuarine Research Reserve	0.05	0.08	0.09	0.18	0.21	0.12
Upper Newport Bay Ecological Reserve	0.20	0.28	0.00	0.00	0.75	0.25
Vandenberg Space Force Base	0.47	0.60	0.24	0.55	0.44	0.46
Venice Beach	0.00	0.54	0.14	0.00	0.00	0.14

APPENDIX B: MAXIMUM TEMPERATURE PROJECTIONS

The Cal-Adapt Annual Averages tool (<https://cal-adapt.org/tools/annual-averages>) was used to estimate projected changes in annual average maximum temperatures at California least tern nesting sites in California (Cal-Adapt 2018, dataset; Pierce et al. 2018, entire). First, we grouped ArcGIS shapefiles of currently active nesting sites into the following five regions: San Francisco Bay area (excludes Sacramento Bufferlands site), San Luis Obispo and Santa Barbara counties, Ventura County, Los Angeles and Orange counties, and San Diego County. Next, we uploaded the shapefiles of nesting sites for each region to the Cal-Adapt Annual Averages tool to calculate historical, mid-century, and end-century annual average maximum temperatures (presented in Table 7). The temperatures are the average of projections from four priority models (i.e., MIROC5, CanESM2, HadGEM2-ES, and CNRM-CM5) for two emissions scenarios, RCP4.5 and RCP8.5. In addition to raw projection data, the following figures (Figure B-1–Figure B-10) were provided by Cal-Adapt.

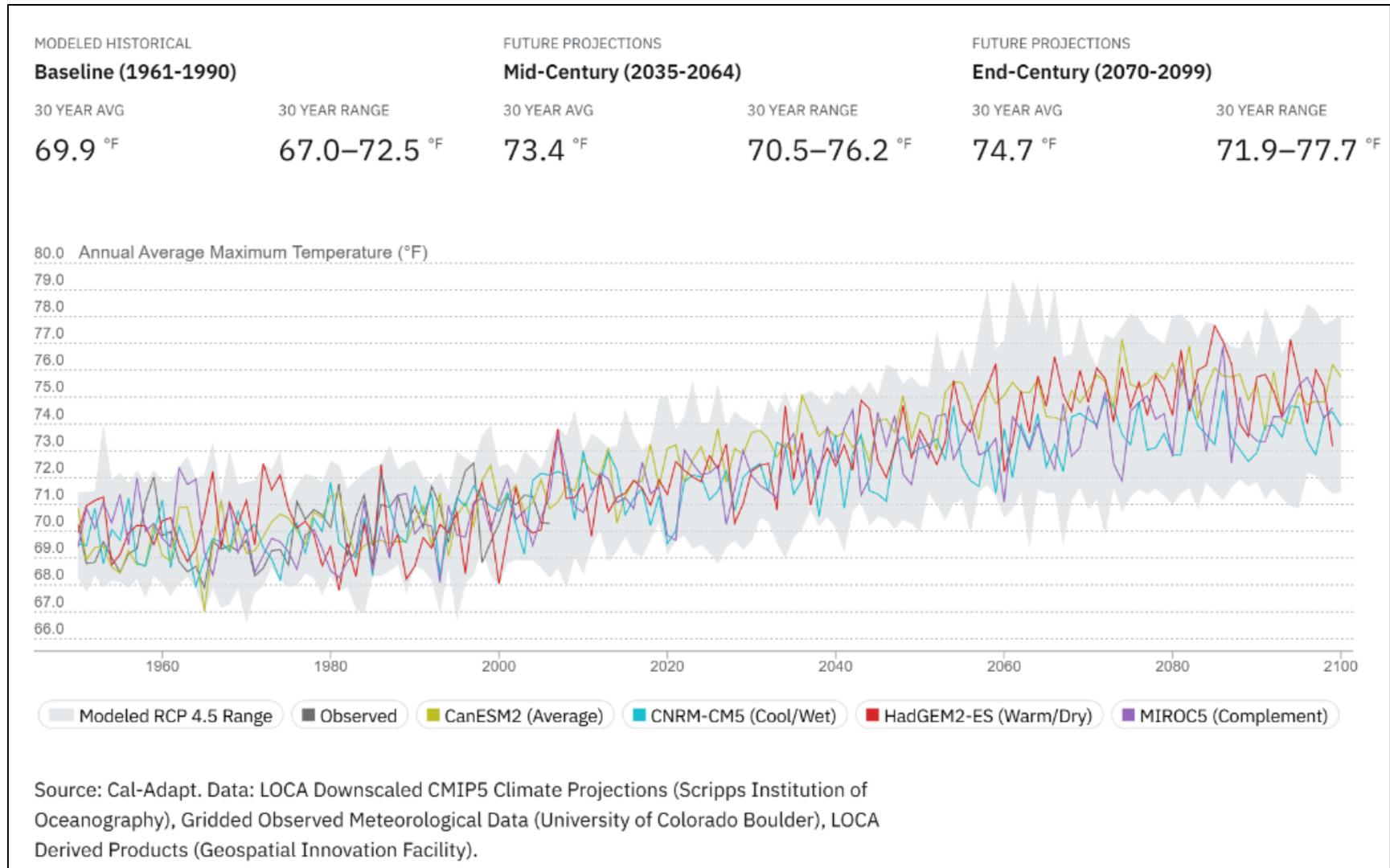


Figure B-1. Projected changes in annual average maximum temperature for currently occupied California least tern nesting sites in the San Francisco Bay area, RCP4.5 emissions scenario (Cal-Adapt 2018, dataset). Units are in degrees Fahrenheit.

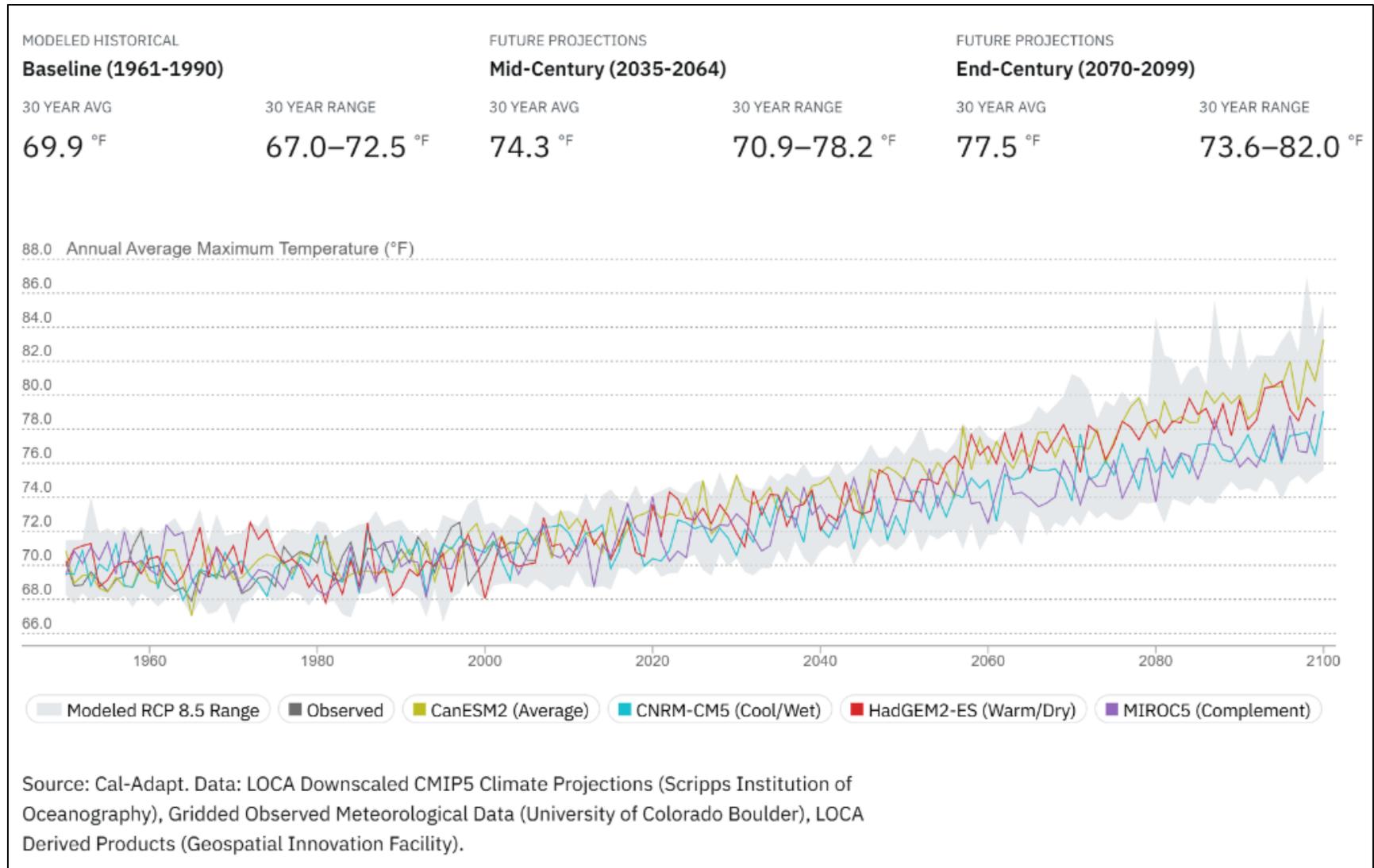


Figure B-2. Projected changes in annual average maximum temperature for currently occupied California least tern nesting sites in the San Francisco Bay area, RCP8.5 emissions scenario (Cal-Adapt 2018, dataset). Units are in degrees Fahrenheit.

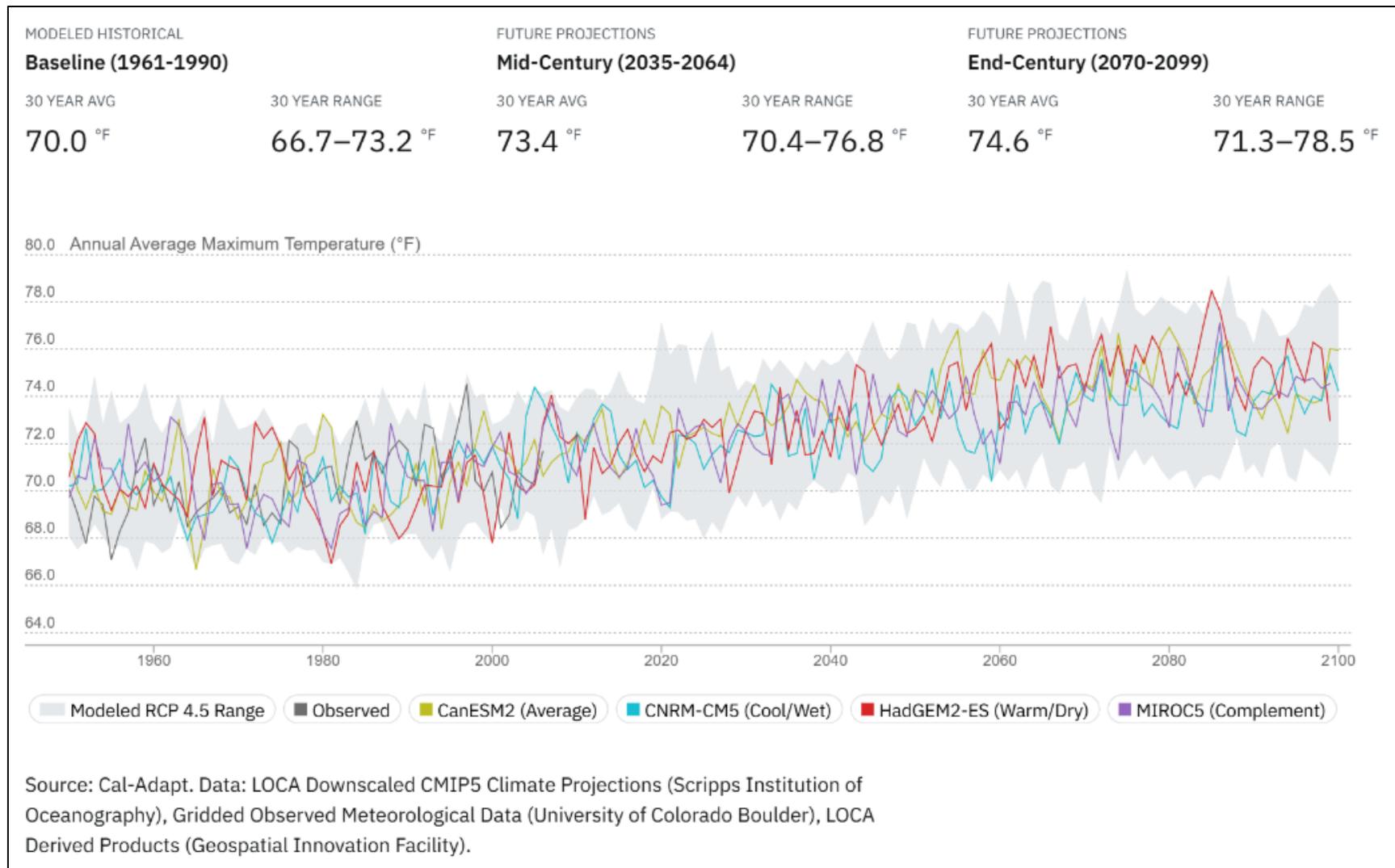


Figure B-3. Projected changes in annual average maximum temperature for currently occupied California least tern nesting sites in San Luis Obispo and Santa Barbara counties, RCP4.5 emissions scenario (Cal-Adapt 2018, dataset). Units are in degrees Fahrenheit.

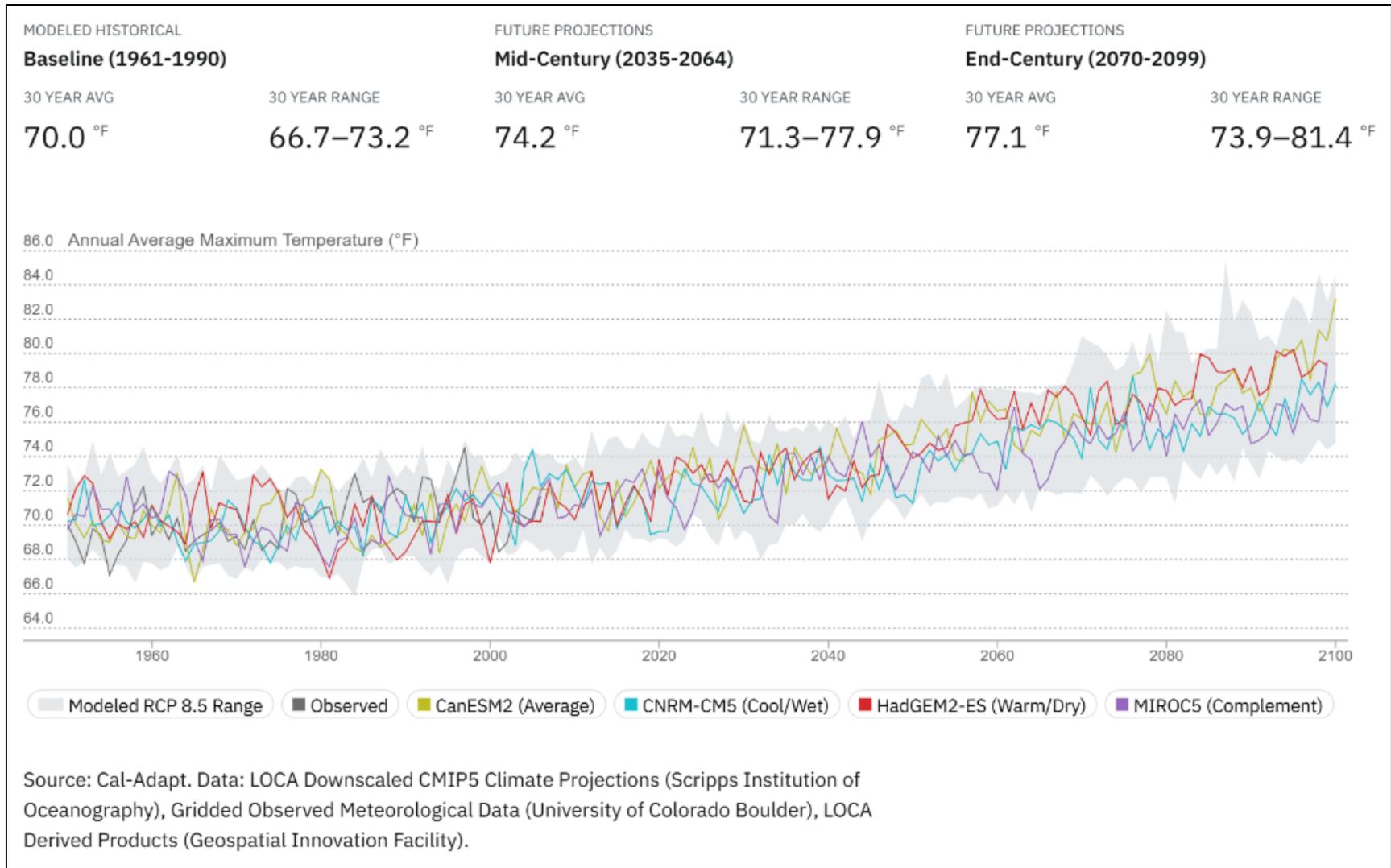


Figure B-4. Projected changes in annual average maximum temperature for currently occupied California least tern nesting sites in San Luis Obispo and Santa Barbara counties, RCP8.5 emissions scenario (Cal-Adapt 2018, dataset). Units are in degrees Fahrenheit.

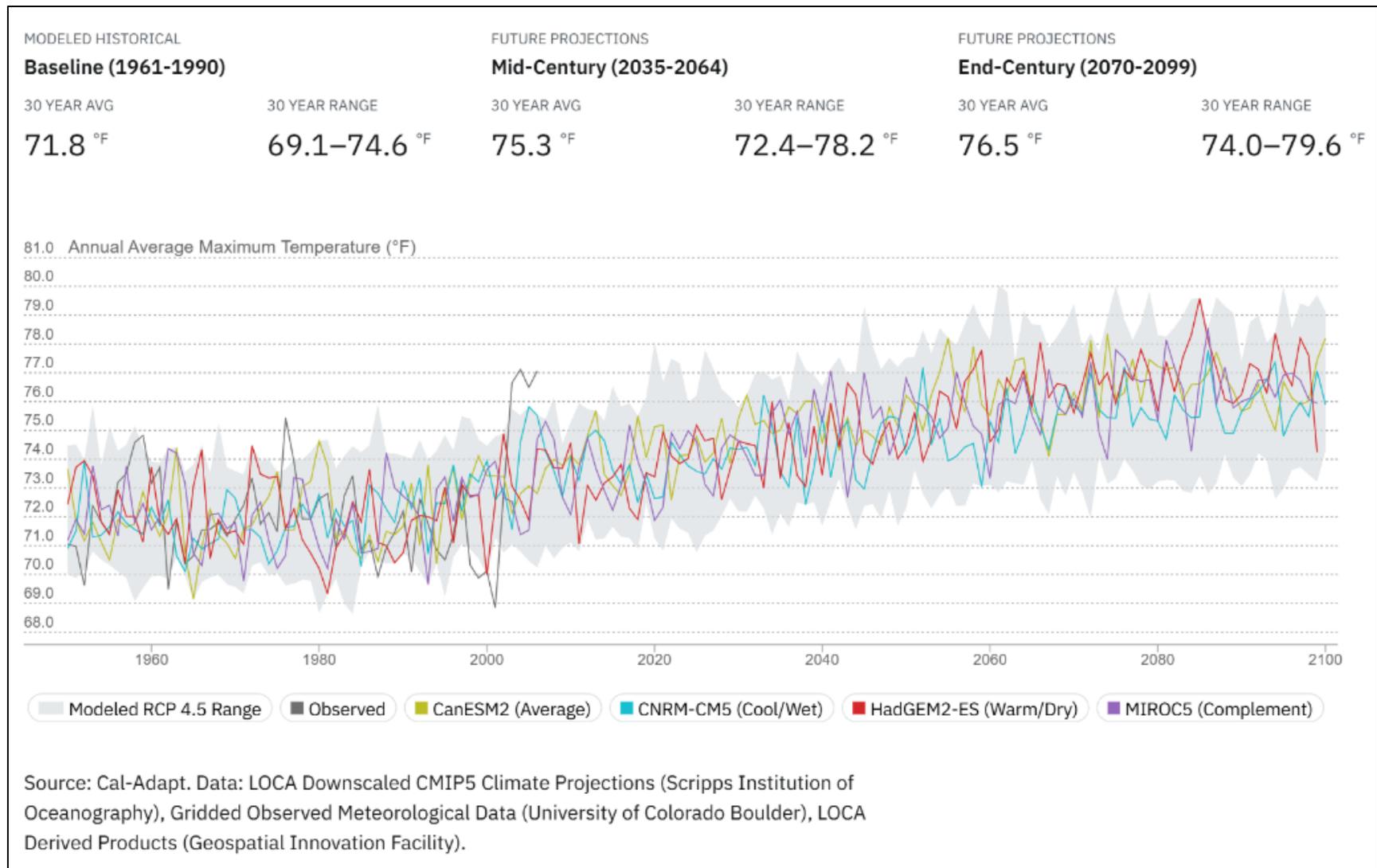


Figure B-5. Projected changes in annual average maximum temperature for currently occupied California least tern nesting sites in Ventura County, RCP4.5 emissions scenario (Cal-Adapt 2018, dataset). Units are in degrees Fahrenheit.

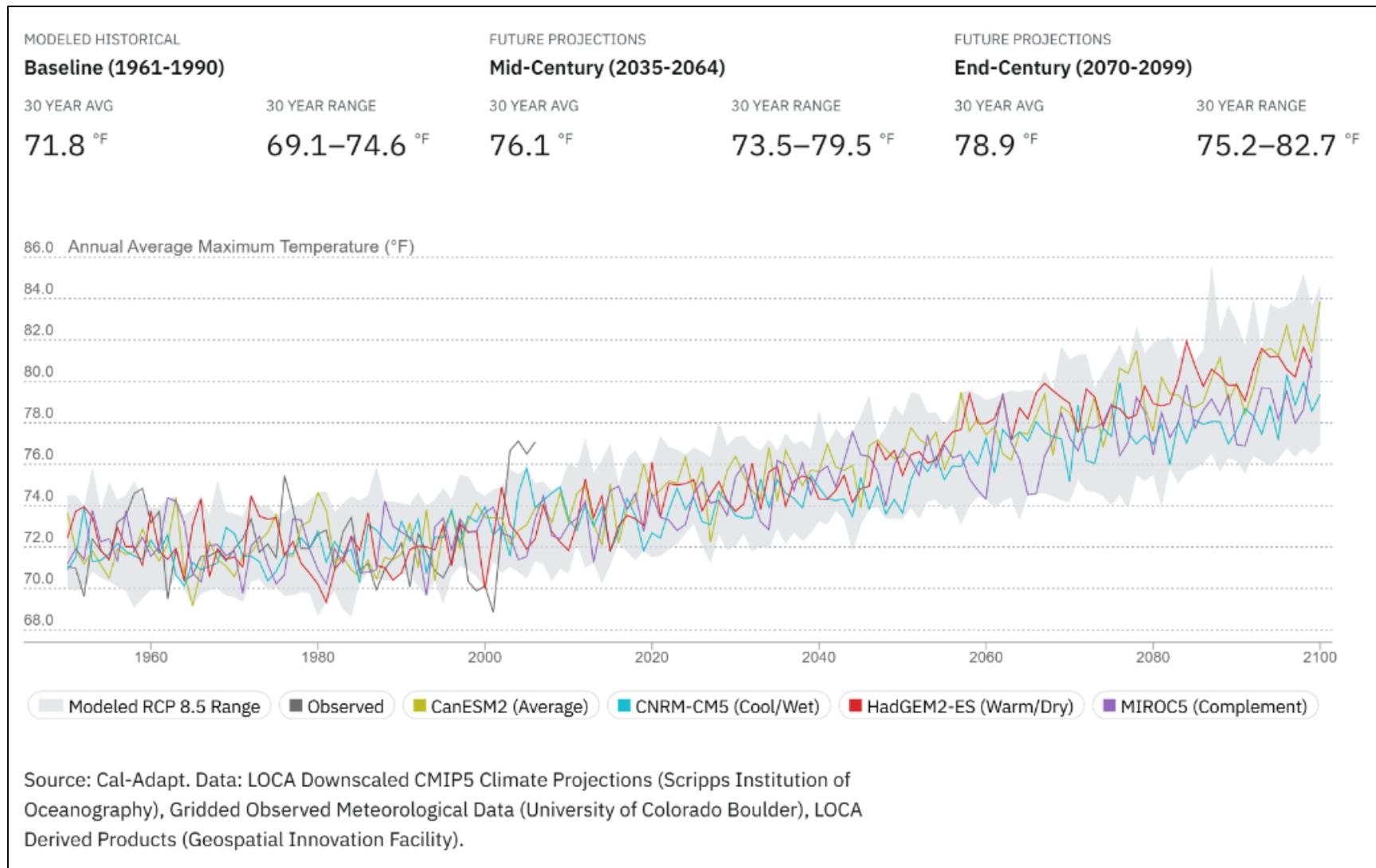


Figure B-6. Projected changes in annual average maximum temperature for currently occupied California least tern nesting sites in Ventura County, RCP8.5 emissions scenario (Cal-Adapt 2018, dataset). Units are in degrees Fahrenheit.

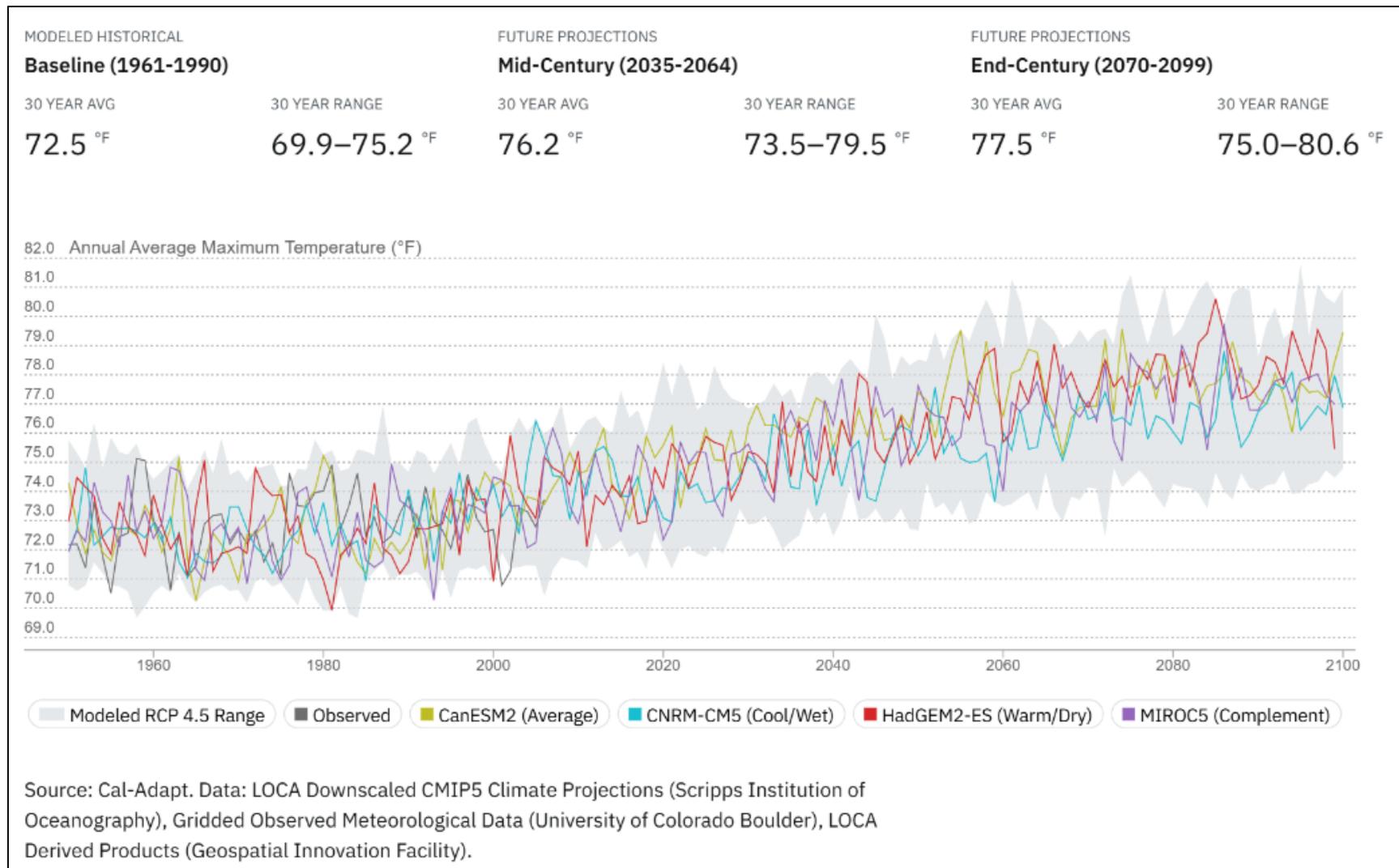


Figure B-7. Projected changes in annual average maximum temperature for currently occupied California least tern nesting sites in Los Angeles and Orange counties, RCP4.5 emissions scenario (Cal-Adapt 2018, dataset). Units are in degrees Fahrenheit.

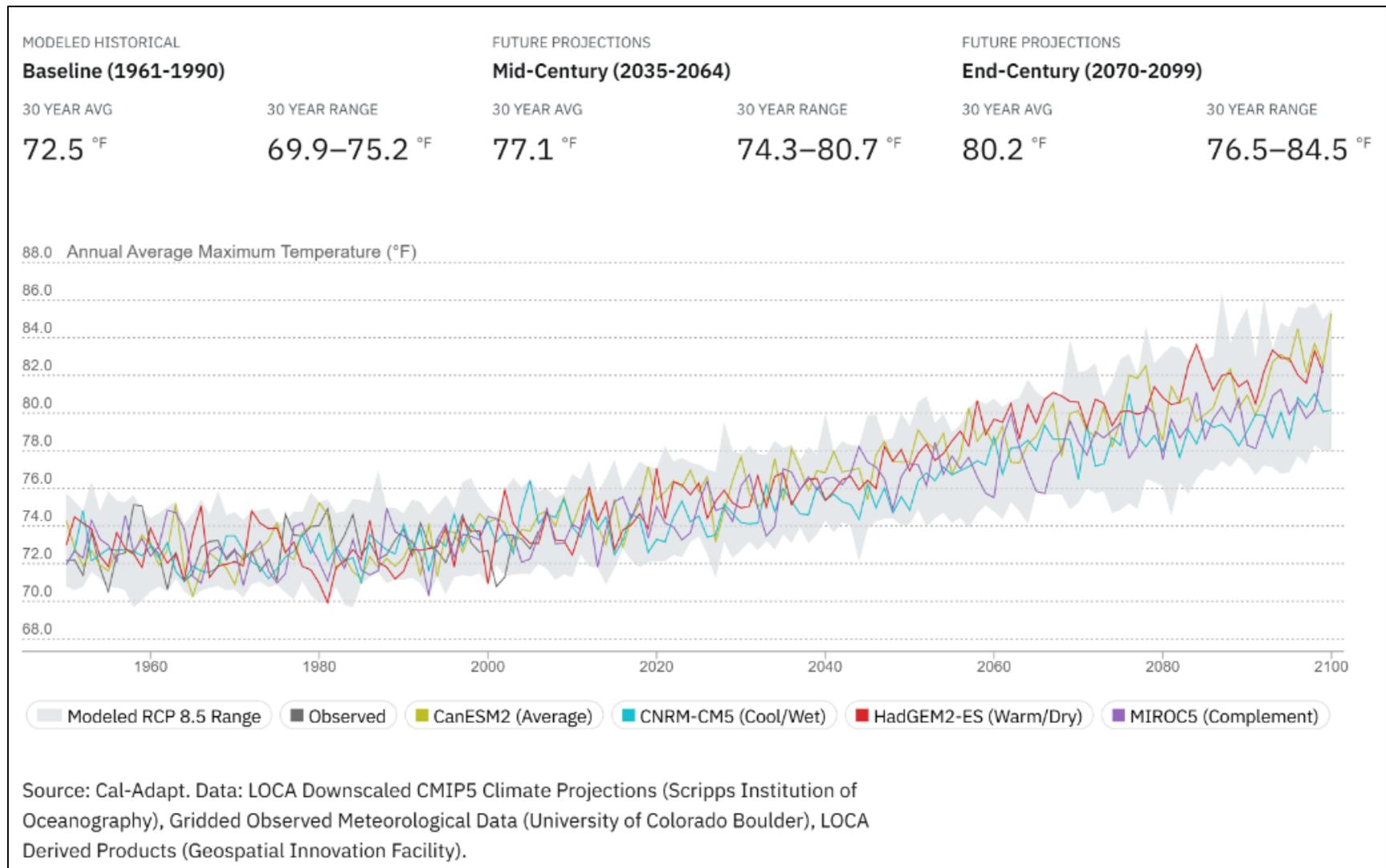


Figure B-8. Projected changes in annual average maximum temperature for currently occupied California least tern nesting sites in Los Angeles and Orange counties, RCP8.5 emissions scenario (Cal-Adapt 2018, dataset). Units are in degrees Fahrenheit.

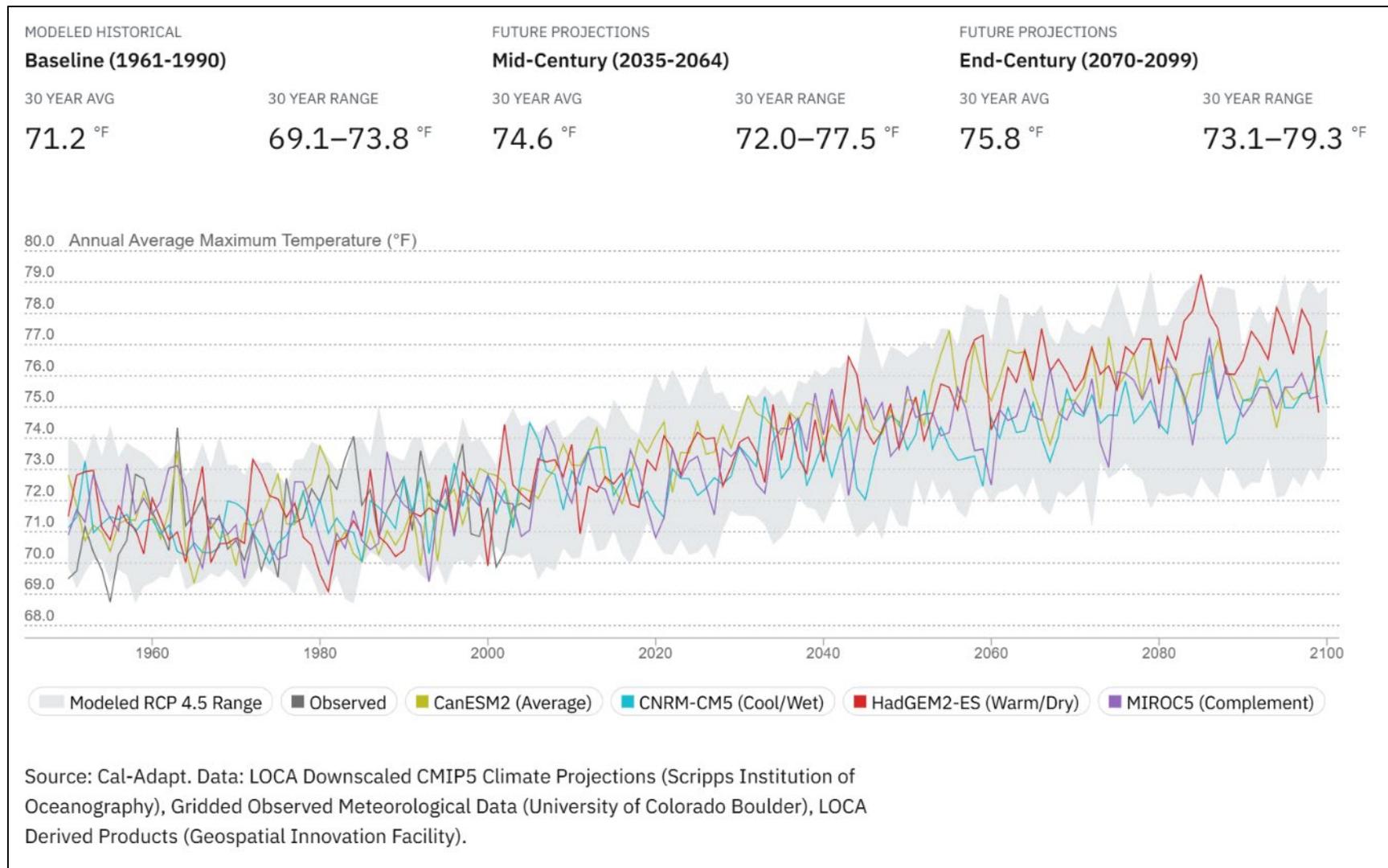


Figure B-9. Projected changes in annual average maximum temperature for currently occupied California least tern nesting sites in San Diego County, RCP4.5 emissions scenario (Cal-Adapt 2018, dataset). Units are in degrees Fahrenheit.

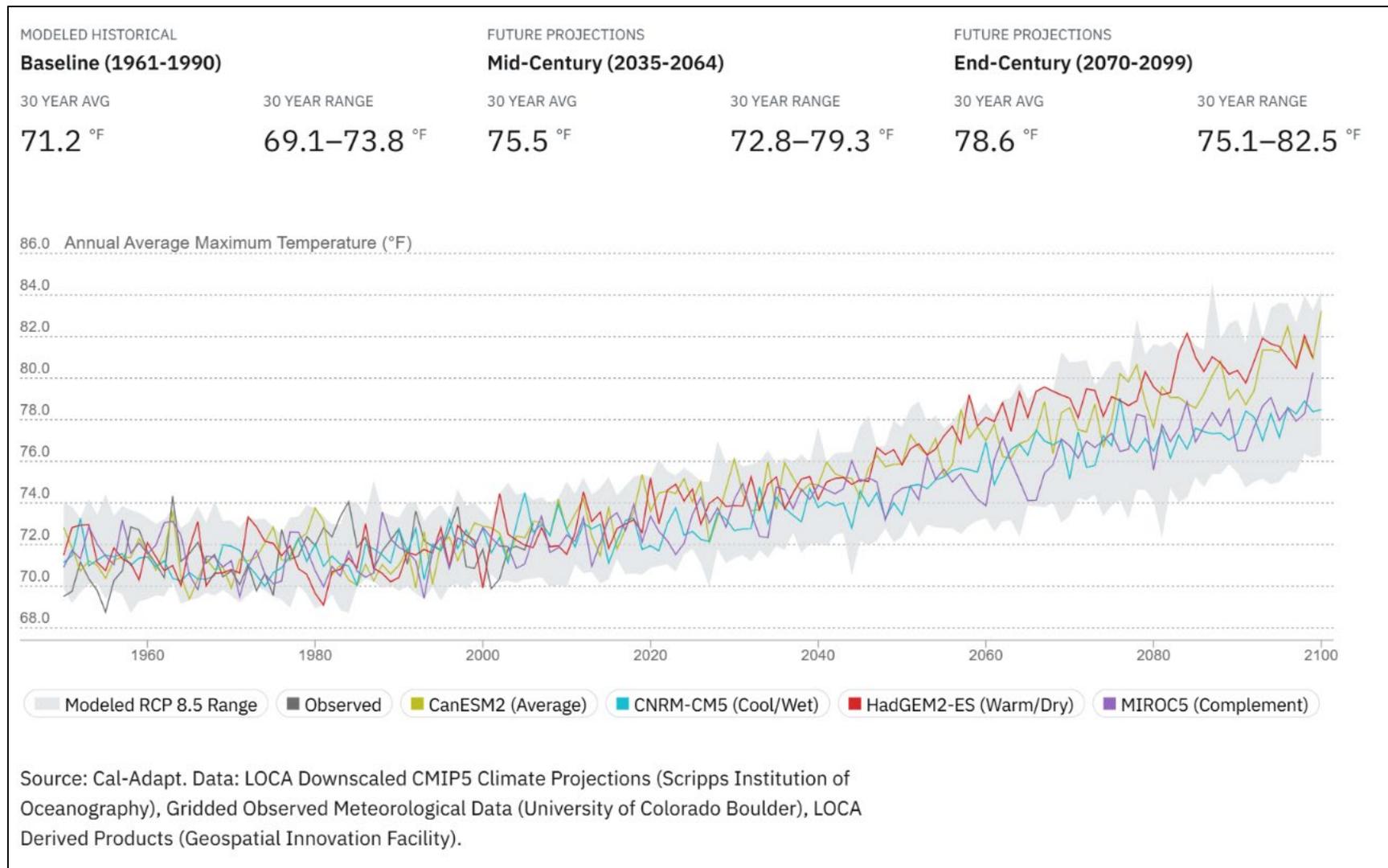


Figure B-10. Projected changes in annual average maximum temperature for currently occupied California least tern nesting sites in San Diego County, RCP8.5 emissions scenario (Cal-Adapt 2018, dataset). Units are in degrees Fahrenheit.

APPENDIX C: SEA LEVEL RISE ANALYSIS

In order to assess the future threats of sea level rise on the California least tern, we first mapped nesting sites that were occupied between 2013–2017. Then we analyzed the potential loss of nesting habitat under various scenarios of sea level rise at 1–5 ft. We selected the levels of sea level rise based on projections outlined in the State of California Sea-Level Rise Guidance document (California Ocean Protection Council 2018). Results from this analysis are detailed in Table C-1.

In order to visualize and understand potential impacts of sea level rise to California least tern nesting habitat, we used the Sea Level Rise and Coastal Flooding Impacts Viewer, developed by the National Oceanic and Atmospheric Administration’s (NOAA’s) Office for Coastal Management (NOAA 2017). This tool offers access to data and information about the risks of sea level rise, storm surge, and flooding along the coastal United States, including California. The NOAA data show the modeled extent and relative depth of inundation from 0 to 6 ft above the mean higher highwater mark (MHHW), as well as confidence levels representing the known error in the elevation data and tidal corrections. Areas are assigned a high confidence of inundation, a low confidence of inundation, or a high confidence that these areas will not be inundated (i.e., remain dry) given the chosen water level represented by the scenario (amount of sea level rise). A high degree of confidence was assigned to the results for locations that may be correctly mapped as “inundated” or “not inundated” at least 8 out of 10 times (i.e., 80 percent). A low degree of confidence was attributed to locations that may be mapped correctly (either as inundated or dry) fewer than 8 out of 10 times. In this analysis, we calculated the amount of inundation probability using both the high confidence (80 percent inundated or not inundated) and the low confidence (20–80 percent) levels that fell in between (Table C1). However, we only categorized probabilities of impacts to nesting areas based on results for inundation with high confidence (80 percent) at the MHHW using 1-ft sea level rise projections for 2050–2060, and 3-ft sea level rise projections for 2100 (Table C2).

Table C-1. Inundation probability at California least tern nesting sites in the United States based on NOAA sea level rise modeling. N/A (not applicable) means the site is inland and not subject to inundation. Ac = acres.

Nesting Area	Sea Level Rise (ft)	High Confidence (80 percent) of No Inundation (ac)	Inundation Probability (percent)	Low Confidence (20 to <80) of Either Inundation or No Inundation (ac)	Inundation Probability (percent)	High Confidence (80 percent) of Inundation (ac)	Inundation Probability (percent)
Alameda Point (9.63 ac)	1	9.63	100	0	0	0	0
	2	9.63	100	0	0	0	0
	3	9.39	97	0.24	3	0	0
	5	5.69	59	3.73	39	0.21	2
Anaheim Lake (0.06 ac)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Batiqitos Lagoon Ecological Reserve (20.87 ac)	1	20.82	100	0.03	0.1	0.03	0.1
	2	20.79	100	0.04	0.2	0.04	0.2
	3	20.75	99	0.07	0.3	0.05	0.3
	5	18.22	87	2.53	12	0.12	1
Bolsa Chica Ecological Reserve (9.86 ac)	1	7.81	79	0.44	4	1.61	16
	2	7.75	79	0.18	2	1.93	20
	3	7.59	77	0.22	2	2.05	21
	5	6.26	64	1.33	14	2.26	23
Sacramento Bufferlands (1.37 ac)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Burriss Sand Pit/Burriss Basin (0.72 ac)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Eden's Landing (176.33 ac)	1	1.35	1	9.96	6	165.02	94
	2	0.46	0	4.71	3	171.16	97
	3	0.09	0	1.53	1	174.71	99
	5	0	0	0.13	0	176.20	100
Hayward Regional Shoreline (0.36 ac)	1	0	0	0.32	91	0.03	9
	2	0	0	0.22	63	0.13	37
	3	0	0	0.01	4	0.34	96
	5	0	0	0	0	0.36	100

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Nesting Area	Sea Level Rise (ft)	High Confidence (80 percent) of No Inundation (ac)	Inundation Probability (percent)	Low Confidence (20 to <80) of Either Inundation or No Inundation (ac)	Inundation Probability (percent)	High Confidence (80 percent) of Inundation (ac)	Inundation Probability (percent)
Hollywood Beach (30.88 ac)	1	19.86	64	1.06	3	9.97	32
	2	18.34	59	2.11	7	10.43	34
	3	14.58	47	5.35	17	10.96	35
	5	9.25	30	5.74	19	15.90	51
Huntington State Beach (10.96 ac)	1	10.96	100	0	0	0	0
	2	10.96	100	0	0	0	0
	3	10.95	100	0.01	0.05	0	0
	5	7.46	68	3.49	32	0	0
L.A. Harbor (14.73 ac)	1	14.73	100	0	0	0	0
	2	14.730	100	0	0	0	0
	3	14.73	100	0	0	0	0
	5	14.73	100	0	0	0	0
Malibu Lagoon (3.57 ac)	1	1.01	28	0.81	23	1.75	49
	2	0.36	10	1.14	32	2.07	58
	3	0.02	0.5	1.07	30	2.49	70
	5	0	0	0.05	1	3.52	98
Marine Corps Base Camp Pendleton (259.03 ac) Blue Beach (88.64 ac)	1	51.24	58	8.98	10	28.42	32
	2	42.08	47	13.90	16	32.66	37
	3	32.92	37	18.73	21	37.00	42
	5	11.76	13	21.56	24	55.33	62
Marine Corps Base Camp Pendleton (259.03 ac) Red Beach (7.54 ac)	1	7.15	95	0.38	5	0	0
	2	7.00	93	0.35	5	0.18	2
	3	6.44	85	0.72	10	0.38	5
	5	5.09	67	1.38	18	1.07	14
Marine Corps Base Camp Pendleton (259.03 ac) Salt Flats (111.72)	1	53.13	48	57.69	52	0.91	1
	2	24.39	22	78.02	70	9.31	8
	3	7.02	6	47.61	43	57.10	51
	5	0	0	7.61	7	104.11	93

2025 5-year Review for the California Least Tern

Nesting Area	Sea Level Rise (ft)	High Confidence (80 percent) of No Inundation (ac)	Inundation Probability (percent)	Low Confidence (20 to <80) of Either Inundation or No Inundation (ac)	Inundation Probability (percent)	High Confidence (80 percent) of Inundation (ac)	Inundation Probability (percent)
Marine Corps Base Camp Pendleton (259.03 ac) White Beach North/Central (17.41 ac)	1	16.24	93	0.94	5	0.24	1
	2	15.51	89	1.19	7	0.71	4
	3	14.43	83	1.86	11	1.12	6
	5	8.41	48	6.09	35	2.91	17
Marine Corps Base Camp Pendleton (259.03 ac) White Beach South (33.72 ac)	1	32.72	97	1.00	3	0	0
	2	31.20	93	2.46	7	0.06	0.2
	3	28.50	85	4.29	13	0.93	3
	5	6.43	19	22.20	66	5.08	15
Mission Bay (23.94 ac) FAA Island (1.58 ac)	1	1.57	99	0.01	1	0	0
	2	1.37	87	0.21	13	0	0
	3	0.51	33	1.05	67	0.01	1
	5	0	0	0.56	35	1.02	65
Mission Bay (23.94 ac) Mariner's Point (2.19 ac)	1	2.19	100	0	0	0	0
	2	2.19	100	0	0	0	0
	3	2.19	100	0	0	0	0
	5	2.16	99	0.03	1	0	0
Mission Bay (23.94 ac) North Fiesta Island (12.52 ac)	1	12.52	100	0	0	0	0
	2	12.52	100	0	0	0	0
	3	12.52	100	0	0	0	0
	5	12.52	100	0	0	0	0
Mission Bay (23.94 ac) San Diego River Mouth (3.16 ac)	1	2.03	64	1.13	36	0	0
	2	1.09	34	1.94	61	0.14	4
	3	0.26	8	1.80	57	1.09	35
	5	0	0	0.31	10	2.86	90
Mission Bay (23.94 ac) Stony Point (4.49 ac)	1	4.49	100	0	0	0	0
	2	4.48	100	0.01	0.2	0	0
	3	4.40	98	0.09	2	0	0
	5	2.82	63	1.60	36	0.07	2

2025 5-year Review for the California Least Tern

Nesting Area	Sea Level Rise (ft)	High Confidence (80 percent) of No Inundation (ac)	Inundation Probability (percent)	Low Confidence (20 to <80) of Either Inundation or No Inundation (ac)	Inundation Probability (percent)	High Confidence (80 percent) of Inundation (ac)	Inundation Probability (percent)
Montezuma Wetlands (0.29 ac)	1	0	0	0	0	0.29	100
	2	0	0	0	0	0.29	100
	3	0	0	0	0	0.29	100
	5	0	0	0	0	0.29	100
Napa Sonoma Marsh Wildlife Area (1.71 ac)	1	0.04	2	0.46	27	1.21	71
	2	0	0	0.24	14	1.46	86
	3	0	0	0.06	4	1.65	96
	5	0	0	0	0	1.71	100
Oceano Dunes SVRA (135.42 ac)	1	135.42	100	0	0	0	0
	2	135.31	100	0.11	0.1	0	0
	3	134.77	100	0.66	0.5	0	0
	5	131.60	97	3.24	2	0.59	0.4
Ormond Beach (45.18 ac)	1	40.54	90	0.23	1	4.41	10
	2	39.73	88	0.94	2	4.50	10
	3	37.13	82	3.42	8	4.63	10
	5	18.01	40	19.43	43	7.74	17
Pittsburg Power Plant (0.59 ac)	1	0.00	0	0.00	0	0.59	100
	2	0.00	0	0.00	0	0.59	100
	3	0.00	0	0.00	0	0.59	100
	5	0.00	0	0.00	0	0.59	100
Pt Mugu (60.42 ac)	1	55.21	91	1.17	2	4.04	7
	2	53.20	88	2.46	4	4.75	8
	3	48.34	80	6.92	11	5.16	9
	5	25.30	42	23.56	39	11.56	19
Chula Vista Wildlife Reserve (4.99 ac)	1	4.48	90	0.20	4	0.31	6
	2	3.71	74	0.93	19	0.35	7
	3	2.49	50	2.00	40	0.50	10
	5	1.17	24	1.42	28	2.40	48

Nesting Area	Sea Level Rise (ft)	High Confidence (80 percent) of No Inundation (ac)	Inundation Probability (percent)	Low Confidence (20 to <80) of Either Inundation or No Inundation (ac)	Inundation Probability (percent)	High Confidence (80 percent) of Inundation (ac)	Inundation Probability (percent)
Naval Air Station North Island, Coronado, MAT Site (19.14 ac)	1	19.14	100	0	0	0	0
	2	19.14	100	0	0	0	0
	3	19.14	100	0	0	0	0
	5	19.14	100	0	0	0	0
Naval Amphibious Base Coronado, Delta Beaches (46.92 ac)	1	44.42	95	2.37	5	0.14	0.3
	2	41.82	89	3.83	8	1.27	3
	3	38.31	82	6.22	13	2.39	5
	5	30.36	65	8.15	17	8.42	18
Naval Amphibious Base Coronado, Oceans (109.45 ac)	1	92.43	84	6.73	6	10.30	9
	2	89.36	82	6.17	6	13.93	13
	3	85.64	78	6.92	6	16.89	15
	5	73.85	67	12.04	11	23.57	22
San Diego International Airport (12.55 ac)	1	12.55	100	0	0	0	0
	2	12.55	100	0	0	0	0
	3	12.55	100	0	0	0	0
	5	5.42	43	7.13	57	0	0
Saltworks (4.98 ac) Note: 0.25 ac outside modeled area	1	3.29	66	0.30	6	1.13	23
	2	2.54	51	0.95	19	1.24	25
	3	1.05	21	2.25	45	1.42	29
	5	0.18	4	0.91	18	3.63	73
D Street Fill (26.68 ac)	1	26.68	100	0	0	0	0
	2	26.68	100	0	0	0	0
	3	25.83	97	0.84	3	0	0
	5	21.21	80	4.66	17	0.81	3
San Dieguito Lagoon (14.68 ac)	1	14.58	99	0.11	1	0.00	0
	2	14.38	98	0.30	2	0.01	0
	3	14.17	97	0.41	3	0.10	1
	5	13.46	92	0.74	5	0.48	3

Nesting Area	Sea Level Rise (ft)	High Confidence (80 percent) of No Inundation (ac)	Inundation Probability (percent)	Low Confidence (20 to <80) of Either Inundation or No Inundation (ac)	Inundation Probability (percent)	High Confidence (80 percent) of Inundation (ac)	Inundation Probability (percent)
Santa Clara River Mouth/McGrath State Beach (55.49 ac)	1	55.38	100	0.05	0.1	0.05	0.1
	2	55.21	100	0.21	0.4	0.07	0.1
	3	55.08	99	0.31	1	0.10	0.2
	5	54.28	98	0.81	1	0.39	1
Seal Beach National Wildlife Refuge - Anaheim Bay (2.45 ac)	1	2.42	99	0.03	1	0	0
	2	2.09	86	0.35	14	0	0
	3	1.13	46	1.30	53	0.01	1
	5	0	0	1.22	50	1.23	50
Tijuana Estuary National Estuarine Research Reserve (22.7 ac)	1	21.87	96	0.72	3	0.11	0.5
	2	20.13	89	2.40	11	0.17	1
	3	17.93	79	4.00	18	0.77	3
	5	13.57	60	4.46	20	4.68	21
Upper Newport Bay Ecological Reserve (3.63 ac)	1	2.06	57	0.56	15	1.02	28
	2	1.80	50	0.55	15	1.29	35
	3	1.47	41	0.60	17	1.56	43
	5	0	0	1.49	41	2.15	59
Vandenberg Space Force Base (66.86 ac)	1	66.42	99	0.17	0.3	0.26	0.4
	2	66.30	99	0.16	0.2	0.39	1
	3	66.27	99	0.15	0.2	0.43	1
	5	66.18	99	0.10	0.1	0.58	1
Venice Beach (7.3 ac)	1	7.30	100	0	0	0	0
	2	7.30	100	0	0	0	0
	3	7.30	100	0	0	0	0
	5	7.30	100	0	0	0	0

Table C-2. Probable inundation of California least tern nesting sites for the likely inundation scenarios in 2050–2060 and 2100 using only the high (80%) confidence model results. Green represents No Loss of Nesting Habitat (0%), yellow represents Minimal Loss (1–20%), tan represents Moderate Loss (21–50%), orange represents Significant Loss (51–99%), red represents Complete Loss (100%). Ac = acres.

Probable Inundation	1 ft Sea Level Rise (2050–2060)	Probable Inundation	3 ft Sea Level Rise (2100)
None (<1%) (643.36 ac)	Alameda Point (9.63 ac)	None (<1%) (417.60 ac)	Alameda Point (9.63 ac)
None (<1%) (643.36 ac)	Anaheim Lake (0.06 ac)	None (<1%) (417.60 ac)	Anaheim Lake (0.06 ac)
None (<1%) (643.36 ac)	Batiquitos Lagoon Ecological Reserve (20.87 ac)	None (<1%) (417.60 ac)	Batiquitos Lagoon Ecological Reserve (20.87 ac)
None (<1%) (643.36 ac)	Huntington State Beach (10.96 ac)	None (<1%) (417.60 ac)	Huntington State Beach (10.96 ac)
None (<1%) (643.36 ac)	L.A. Harbor (14.73 ac)	None (<1%) (417.60 ac)	L.A. Harbor (14.73 ac)
None (<1%) (643.36 ac)	Marine Corps Base Camp Pendleton, Red Beach (7.54 ac)	None (<1%) (417.60 ac)	Mission Bay, FAA Island (1.58 ac)
None (<1%) (643.36 ac)	Marine Corps Base Camp Pendleton, Salt Flats (111.72 ac)	None (<1%) (417.60 ac)	Mission Bay, Mariner's Point (2.19 ac)
None (<1%) (643.36 ac)	Marine Corps Base Camp Pendleton, White Beach South (33.72 ac)	None (<1%) (417.60 ac)	Mission Bay, North Fiesta Island (12.52 ac)
None (<1%) (643.36 ac)	Mission Bay, FAA Island (1.58 ac)	None (<1%) (417.60 ac)	Mission Bay, Stony Point (4.49 ac)
None (<1%) (643.36 ac)	Mission Bay, Mariner's Point (2.19 ac)	None (<1%) (417.60 ac)	Oceano Dunes SVRA (135.42 ac)
None (<1%) (643.36 ac)	Mission Bay, North Fiesta Island (12.52 ac)	None (<1%) (417.60 ac)	San Diego Bay, D Street Fill (26.68 ac)
None (<1%) (643.36 ac)	Mission Bay, San Diego River Mouth (3.16 ac)	None (<1%) (417.60 ac)	San Diego Bay, Naval Air Station North Island, Coronado, MAT Site (19.14 ac)
None (<1%) (643.36 ac)	Mission Bay, Stony Point (4.49 ac)	None (<1%) (417.60 ac)	San Diego Bay, San Diego International Airport (12.55 ac)
None (<1%) (643.36 ac)	Oceano Dunes SVRA (135.42 ac)	None (<1%) (417.60 ac)	San Dieguito Lagoon (14.68 ac)
None (<1%) (643.36 ac)	San Diego Bay, D Street Fill (26.68 ac)	None (<1%) (417.60 ac)	Santa Clara River Mouth/McGrath State Beach (55.49 ac)

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Probable Inundation	1 ft Sea Level Rise (2050–2060)	Probable Inundation	3 ft Sea Level Rise (2100)
None (<1%) (643.36 ac)	San Diego Bay, Naval Amphibious Base Coronado, Delta Beaches (46.92 ac)	None (<1%) (417.60 ac)	Seal Beach National Wildlife Refuge - Anaheim Bay (2.45 ac)
None (<1%) (643.36 ac)	San Diego Bay, Naval Air Station North Island, Coronado, MAT Site (19.14 ac)	None (<1%) (417.60 ac)	Vandenberg Space Force Base (66.86 ac)
None (<1%) (643.36 ac)	San Diego Bay, San Diego International Airport (12.55 ac)	None (<1%) (417.60 ac)	Venice Beach (7.3 ac)
None (<1%) (643.36 ac)	San Dieguito Lagoon (14.68 ac)	Minimal (1-20%) (358.19 ac)	Bolsa Chica Ecological Reserve (9.86 ac)
None (<1%) (643.36 ac)	Santa Clara River Mouth/McGrath State Beach (55.49 ac)	Minimal (1-20%) (358.19 ac)	Marine Corps Base Camp Pendleton, Red Beach (7.54 ac)
None (<1%) (643.36 ac)	Seal Beach National Wildlife Refuge - Anaheim Bay (2.45 ac)	Minimal (1-20%) (358.19 ac)	Marine Corps Base Camp Pendleton, White Beach North/Central (17.41 ac)
None (<1%) (643.36 ac)	Tijuana Estuary National Estuarine Research Reserve (22.7 ac)	Minimal (1-20%) (358.19 ac)	Marine Corps Base Camp Pendleton, White Beach South (33.72 ac)
None (<1%) (643.36 ac)	Vandenberg Space Force Base (66.86 ac)	Minimal (1-20%) (358.19 ac)	Ormond Beach (45.18 ac)
None (<1%) (643.36 ac)	Venice Beach (7.3 ac)	Minimal (1-20%) (358.19 ac)	Pt Mugu (60.42 ac)
Minimal (1-20%) (247.67 ac)	Bolsa Chica Ecological Reserve (9.86 ac)	Minimal (1-20%) (358.19 ac)	San Diego Bay, Chula Vista Wildlife Reserve (4.99 ac)
Minimal (1-20%) (247.67 ac)	Hayward Regional Shoreline (0.36 ac)	Minimal (1-20%) (358.19 ac)	San Diego Bay, Naval Amphibious Base Coronado, Delta Beaches (46.92 ac)
Minimal (1-20%) (247.67 ac)	Marine Corps Base Camp Pendleton, White Beach North/Central (17.41 ac)	Minimal (1-20%) (358.19 ac)	San Diego Bay, Naval Amphibious Base Coronado, Oceans (109.45 ac)
Minimal (1-20%) (247.67 ac)	Ormond Beach (45.18 ac)	Minimal (1-20%) (358.19 ac)	Tijuana Estuary National Estuarine Research Reserve (22.7 ac)
Minimal (1-20%) (247.67 ac)	Pt Mugu (60.42 ac)	Moderate (21-50%) (131.28 ac)	Hollywood Beach (30.88 ac)
Minimal (1-20%) (247.67 ac)	San Diego Bay, Chula Vista Wildlife Reserve (4.99 ac)	Moderate (21-50%) (131.28 ac)	Marine Corps Base Camp Pendleton, Blue Beach (88.64 ac)
Minimal (1-20%) (247.67 ac)	San Diego Bay, Naval Amphibious Base Coronado, Oceans (109.45 ac)	Moderate (21-50%) (131.28 ac)	Mission Bay, San Diego River Mouth (3.16 ac)
Moderate (21-50%) (131.70 ac)	Hollywood Beach (30.88 ac)	Moderate (21-50%) (131.28 ac)	San Diego Bay, Saltworks (4.98 ac)
Moderate (21-50%) (131.70 ac)	Malibu Lagoon (3.57 ac)	Moderate (21-50%) (131.28 ac)	Upper Newport Bay Ecological Reserve (3.63 ac)

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Probable Inundation	1 ft Sea Level Rise (2050–2060)	Probable Inundation	3 ft Sea Level Rise (2100)
Moderate (21-50%) (131.70 ac)	Marine Corps Base Camp Pendleton, Blue Beach (88.64 ac)	Significant (51-99%) (117.36 ac)	Hayward Regional Shoreline (0.36 ac)
Moderate (21-50%) (131.70 ac)	San Diego Bay, Saltworks (4.98 ac)	Significant (51-99%) (117.36 ac)	Malibu Lagoon (3.57 ac)
Moderate (21-50%) (131.70 ac)	Upper Newport Bay Ecological Reserve (3.63 ac)	Significant (51-99%) (117.36 ac)	Marine Corps Base Camp Pendleton, Salt Flats (111.72 ac)
Significant (51-99%) (178.04 ac)	Eden's Landing (176.33 ac)	Significant (51-99%) (117.36 ac)	Napa Sonoma Marsh Wildlife Area (1.71 ac)
Significant (51-99%) (178.04 ac)	Napa Sonoma Marsh Wildlife Area (1.71 ac)	Complete (100%) (177.21 ac)	Eden's Landing (176.33 ac)
Complete (100%) (0.88 ac)	Montezuma Wetlands (0.29 ac)	Complete (100%) (177.21 ac)	Montezuma Wetlands (0.29 ac)
Complete (100%) (0.88 ac)	Pittsburg Power Plant (0.59 ac)	Complete (100%) (177.21 ac)	Pittsburg Power Plant (0.59 ac)

FIELD OFFICE APPROVAL

Lead Field Supervisor, Fish and Wildlife Service

Approve

Jonathan Snyder
Acting Field Supervisor

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