Seabirds and ocean conditions from the CalCOFI/CCE-LTER Survey: Spring 2025 data report

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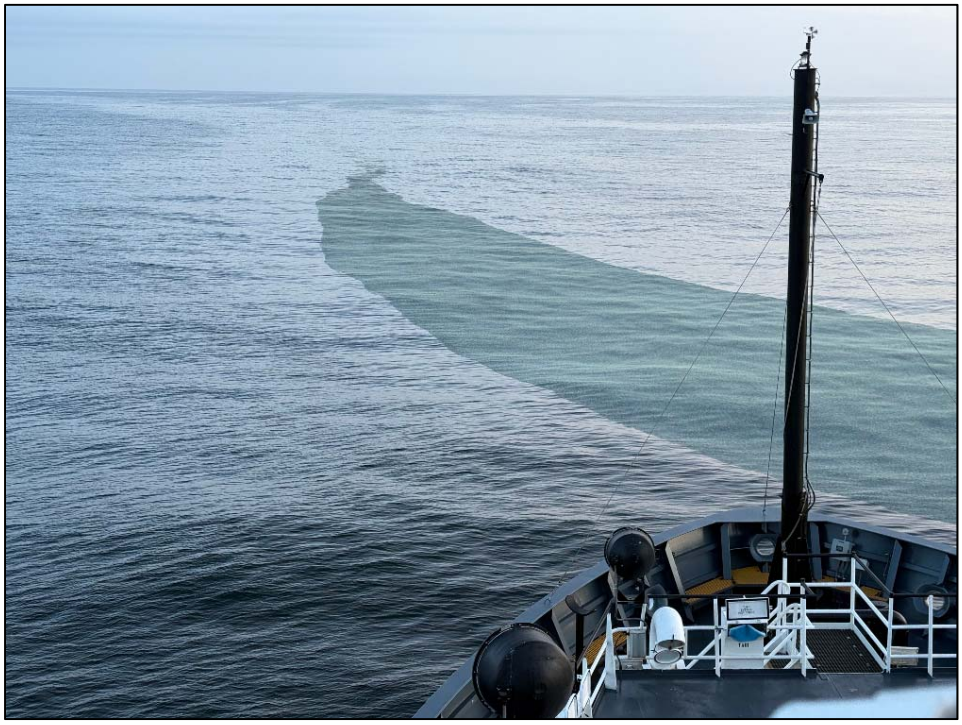

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Cover photo: Patch of *Velella velella*. Photo by Michael Force.

Introduction

Seabird surveys are an integral part of the California Cooperative Oceanic Fisheries Investigation (CalCOFI), California Current Ecosystem - Long-term Ecological Research (CCE-LTER), and Southern California Coastal Ocean Observing System (SCCOOS) programs. The seabird data are valuable for several reasons. First, information on seabird distribution and abundance provides an upper trophic level perspective that complements the lower trophic level plankton and hydrographic data collected by others. Second, estimates of seabird abundance, diversity, and distribution contribute to understanding the spatial ecology of the Southern California Bight and adjacent marine habitats (e.g., Santora et al. 2017), a region characterized by substantial temporal environmental heterogeneity and a major biogeographic boundary at Point Conception. Third, by extending our existing records (currently 39 years and building; 1987–present) and coupling this information with long-term hydrographic and plankton data, seabird data contribute to understanding the effects of climate variability and change on the southern sector of the CCE (e.g., Veit et al. 1996, Hyrenbach and Veit 2003, Santora and Sydeman 2015, Sydeman et al. 2015).

This data report summarizes observations made within the CalCOFI core region during the 2025 spring CalCOFI/CCE-LTER cruise. We include data on survey effort as well as summary information on seabird abundance, expressed at density (birds/km^2), and oceanographic conditions during the survey period.

Methods

Oceanographic conditions. We present sea surface temperature (SST; C°) and wind averages for the period 20 March 2025 to 20 April 2025 for the full CalCOFI survey area. SST and SST anomaly (SSTa) data were downloaded from the high-resolution Optimal Interpolation SST V.2.1 (OISST) dataset (https://psl.noaa.gov/data/gridded/data.noaa.oisst.v2.highres.html), and wind (speed and direction) data were downloaded for NOAA/NDBC buoys (https://www.ndbc.noaa.gov/). Additionally, daily SST and wind averages for the study period are shown specifically for NOAA/NDBC buoy 46011 (https://www.ndbc.noaa.gov/station_page.php?station=46011).

Seabird observations. Observations of seabirds are made continuously during daylight ship transits between oceanographic/plankton sampling stations. The observer, located on the flying bridge approximately 15 meters above sea level, uses hand-held binoculars and occasionally also a digital camera to assist in the identification and enumeration of birds. The observer records all birds seen within a 300-meter strip transect to one side and front of the vessel while the ship is underway at > 5 knots. Observations are entered into a computer using the dedicated application "DLog"; the ship's position is automatically recorded periodically from an external GPS every 20 seconds. Each observation includes the species, the number of individuals observed, and their behavior (mostly "flying" or "sitting on the water"). Observation data are post-processed using standardized species codes, validation of positioning data, and binning of observations into

along-track sections of 3 km in length. The data are then integrated into a survey database that contains data from 1987 to the present. These data are used to derive summary statistics.

Calculation of seabird densities. Taxa excluded from this summary were all mammals, fish, terrestrial birds, and most shorebirds except phalaropes, which can be found in the pelagic realm. Species densities were calculated as the total number of individuals observed per species divided by the area (km^2) surveyed. Density is expressed by $\log_{10}$ function; a constant of 0.01 was added to each species' density prior to transformation. Anomalies of $\log_{10}$-transformed density over time are shown for selected species for the period 1987 through 2025, spring only. In phylogenetic order, species included were sooty shearwater *Ardenna grisea*, pink-footed shearwater *A. creatopus*, black-footed albatross *Phoebastria nigripes*, Laysan albatross *P. immutabilis*, Cook's petrel *Pterodroma cookii*, a Leach's storm-petrel complex (Leach's storm-petrel *Hydrobates leucorhous*, Townsend's storm-petrel *H. socorroensis*, Ainley's storm-petrel *H. cheimomnestes*, and unidentified Leach's storm-petrels), small alcids (grouped Scripps' murrelet *Synthliboramphus scrippsi*, Xantus'/Craveri's murrelet *S. craveri*, and Guadalupe murrelet *S. hypoleucus*), Cassin's auklet *Ptychoramphus aleuticus*, common murre *Uria aalge*, rhinoceros auklet *Cerorhinca monocerata*, Brandt's cormorant *Urile penicillatus*, brown pelican *Pelecanus occidentalis*, western gull *Larus occidentalis*, Sabine's gull *Xema sabini*, and phalaropes (grouped red phalarope *Phalaropus fulicaria* and red-necked phalarope *P. lobatus*). Trends in seabird density were examined using Spearman rank correlation.

Results

Oceanographic conditions. The spring CalCOFI survey transited through a wide range of water temperatures, with the nearshore waters north of Point Conception being substantially cooler (blue tones) than the offshore waters in the southern portion of the transect (red tones; Figure 1A). Conversely, when observing the SSTa map, only the nearshore waters for the coastline south of Monterey Bay and off Baja California were cooler than the long-term seasonal average versus much of the offshore waters were warmer than average (Figure 1B). During the start of the cruise, winds were blowing mostly from the east and water temperature declined steadily. As the cruise ended, the winds diminished and water temperature rose again (Figure 2).

Surveying effort. A summary of survey effort is shown in Table 1; transects surveyed are shown in Figure 1. Summarized species observations for all species are shown in Table 2 (see Appendix 1 for exclusions). Survey effort over 28 days covered 2,751 km (825 km^2) of ocean habitat both within and north of the core survey area (Figure 3). Surveying spanned one month, and there was a break for a few days while the ship was in San Diego for a port call.

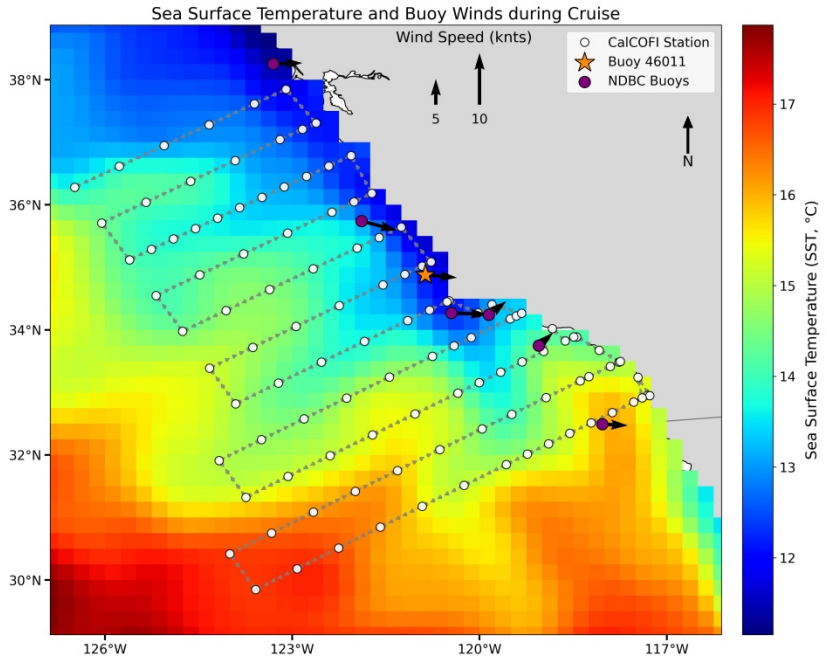
Seabirds. Density over time for the selected seabird species (listed above) was calculated for the core survey area and is shown as anomalies in Figures 4–7. Both shearwater species were present at near-average densities (Figure 4). Black-footed albatross were seen at near-average density and Laysan albatross had above-average density (Figure 4). Overall density of Laysan albatross is regularly very low in the spring season, with not much variability. Cook's petrel had above-average density, logging the second-highest value in the time series (Figure 4). Birds in the Leach's storm-petrel complex were present at a below-average average density within 1 s.d. of the mean (Figure 4). There were no observations of birds in the small alcid group and there were

only two Cassin's auklets seen, however, above-average densities were seen for common murre (within 1 s.d.) and rhinoceros auklet (near 1 s.d. of the mean; Figure 5). Brandt's cormorants were present at just over 1 s.d. of average density, and brown pelicans had the highest observed density in their time series (Figure 6). Western gull had slightly lower than average density, and no Sabine's gulls were seen (Figure 6). Phalaropes were present at slightly more than average density (Figure 6).

Rank correlation analysis showed increasing at-sea abundance for migrant pink-footed shearwater, and locally-breeding common murre, rhinoceros auklet, and Brandt's cormorant. Decreasing abundance was found for black-footed albatross, and Cassin's auklet ($p < 0.1$; Table 3).

Figure 1. Ocean conditions in the greater CalCOFI area for the period 20 March 2025 to 20 April 2025. White dots indicate CalCOFI sampling stations and NOAA/NDBC buoys are indicated with purple dots and orange star. A) Sea surface temperature (SST; C°) and wind averages (speed and direction the wind is blowing). B) Sea surface temperature anomalies (SSTa; C°) averages were derived from a MUR climatology.

A)



B)

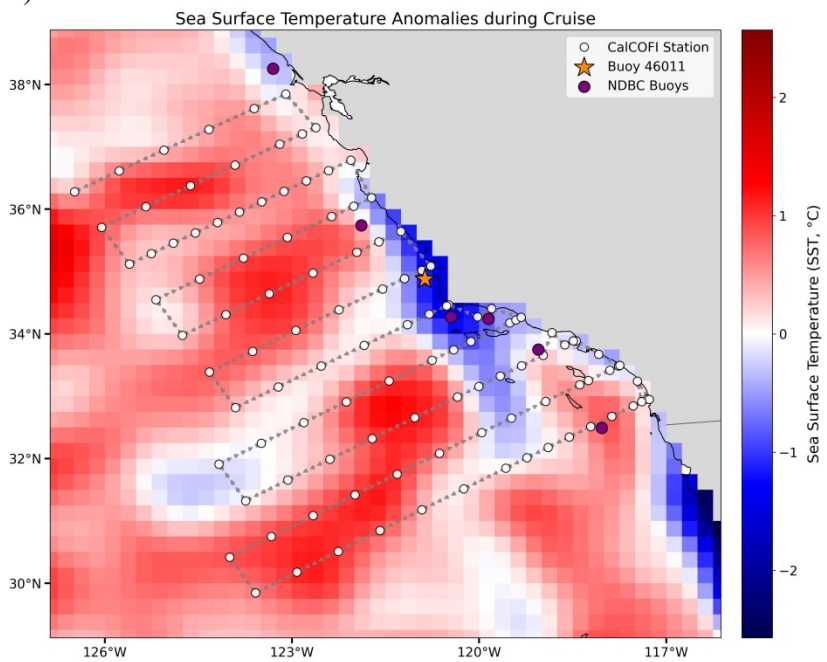


Figure 2. Daily SST (C°) and wind averages for the period 20 March 2025 to 20 April 2025 at NOAA/NDBC buoy 46011; location is marked in Figure 1 with an orange star. The beginning of the cruise is shown with a dashed vertical line. Bottom panel: arrow direction indicates the direction the wind is blowing (up = north) and the y-axis indicates wind speed scale in knots. Upwelling-favorable winds are strong winds to the southeast.

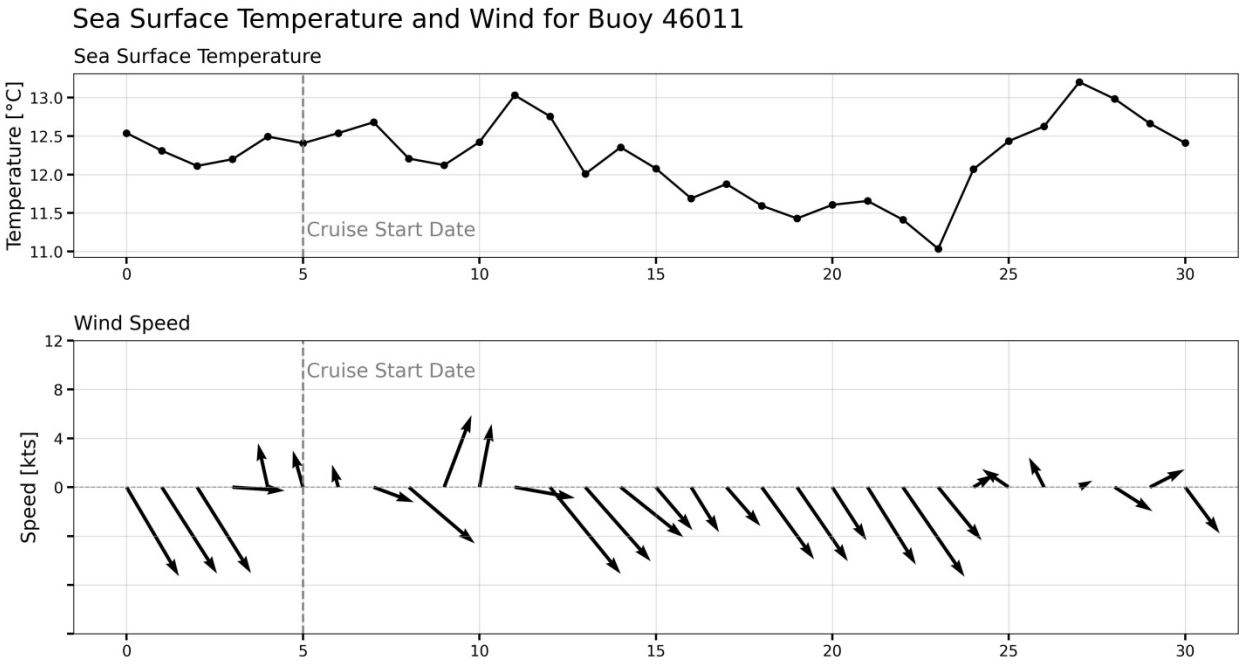


Table 1. Summary of survey effort and seabird statistics for the full and core survey areas, spring 2025.

Spring 2025	Full survey area	Core survey area
Survey vessel	RV *Bell M. Shimada*	
Start date	3/20/2025	
End date	4/20/2025	
Number of survey days	28	18
Distance surveyed (km)	2,751	1,817
Area surveyed (km^2)	825	545
Number of bird species	41	38
Overall bird density (per km^2)	10.667	4.238
Total individuals counted	8,803	2,310

Figure 3. Transects sampled during the CalCOFI spring 2025 survey. The core study area is denoted with the box, and includes CalCOFI lines 93 (south) to 77 (north).

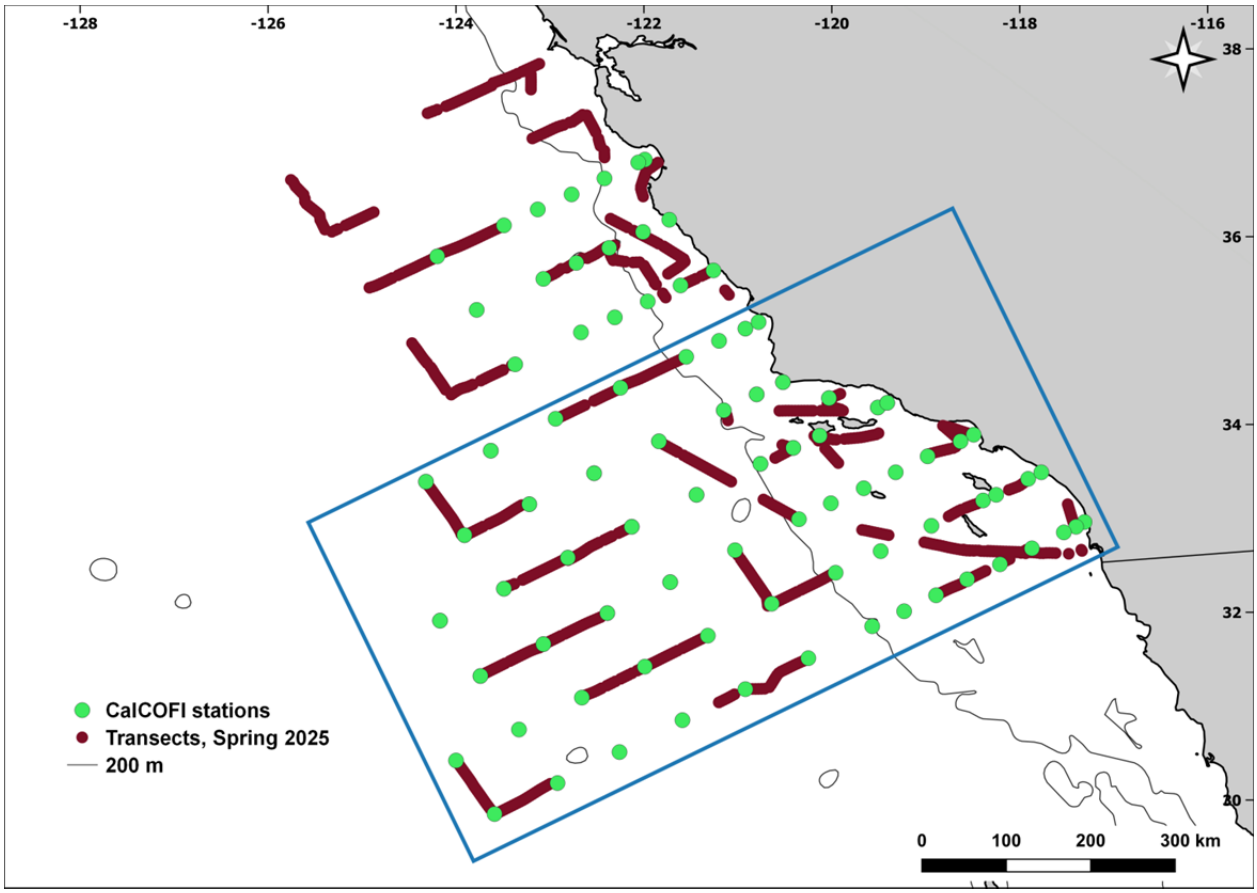


Table 2. Observations in spring 2025 by species in the full and core survey areas (see Figure 3). Cell values: total number of individuals (ind.) / number of observations per species (obs.) / species density (dens.) in individuals per km^2.

Common Name	Scientific Name	Full area	Core area
American white pelican	*Pelecanus erythrorhynchos*		
Ancient murrelet	*Synthliboramphus antiquus*		
Arctic loon	*Gavia arctica*		
Arctic tern	*Sterna paradisaea*		
Ashy storm-petrel	*Hydrobates homochroa*	3 / 2 / 0	1 / 1 / 0
Black guillemot	*Cepphus grylle*		
Black scoter	*Melanitta americana*		
Black storm-petrel	*Hydrobates melania*		
Black-footed albatross	*Phoebastria nigripes*	45 / 39 / 0.05	15 / 13 / 0.03
Black-legged kittiwake	*Rissa tridactyla*		
Black-vented shearwater	*Puffinus opisthomelas*		
Bonaparte's gull	*Chroicocephalus philadelphia*	432 / 40 / 0.52	96 / 21 / 0.18
Brandt's cormorant	*Urile penicillatus*	276 / 57 / 0.33	248 / 40 / 0.45
Brant	*Branta bernicla*		
Brown booby	*Sula leucogaster*		
Brown noddy	*Anous stolidus*		
Brown pelican	*Pelecanus occidentalis*	254 / 57 / 0.31	249 / 53 / 0.46
Buller's shearwater	*Ardenna bulleri*		
California gull	*Larus californicus*	570 / 177 / 0.69	343 / 131 / 0.63
Caspian tern	*Hydroprogne caspia*	1 / 1 / 0	1 / 1 / 0
Cassin's auklet	*Ptychoramphus aleuticus*	59 / 26 / 0.07	2 / 2 / 0
Clark's grebe	*Aechmophorus clarkii*		
Common loon	*Gavia immer*	3 / 3 / 0	1 / 1 / 0
Common murre	*Uria aalge*	1925 / 224 / 2.33	28 / 12 / 0.05
Common tern	*Sterna hirundo*		
Cook's petrel	*Pterodroma cookii*	219 / 90 / 0.27	207 / 83 / 0.38
Craveri's murrelet	*Synthliboramphus craveri*		
Dark shearwater	(species group)		
Dark-rumped petrel	*Pterodroma phaeopygia sandwichensis*		
Double-crested cormorant	*Nannopterum auritum*		
Eared grebe	*Podiceps nigricollis*	2 / 1 / 0	2 / 1 / 0
Elegant tern	*Thalasseus elegans*	20 / 10 / 0.02	20 / 10 / 0.04
Flesh-footed shearwater	*Ardenna carneipes*		
Fork-tailed storm-petrel	*Hydrobates furcata*		
Forster's tern	*Sterna forsteri*		
Franklin's gull	*Leucophaeus pipixcan*		
Glaucous gull	*Larus hyperboreus*		
Glaucous-winged gull	*Larus glaucescens*	2 / 2 / 0	1 / 1 / 0
Glaucous-winged/Western hybrid gull			
Guadalupe murrelet	*Synthliboramphus hypoleucus*		
Hawaiian petrel	*Pterodroma sandwichensis*	3 / 3 / 0	2 / 2 / 0
Heermann's gull	*Larus heermanni*	1 / 1 / 0	
Herring gull	*Larus argentatus*	31 / 26 / 0.04	22 / 17 / 0.04
Horned puffin	*Fratercula corniculata*		
Hybrid gull	(species group)		

Juan Fernandez petrel	*Pterodroma externa*		
Kelp gull	*Larus dominicanus*		
Kermadec petrel	*Pterodroma neglecta*		
Laughing gull	*Leucophaeus atricilla*		
Laysan albatross	*Phoebastria immutabilis*	16 / 12 / 0.02	10 / 6 / 0.02
Leach's storm-petrel complex	(species group)		
Least storm-petrel	*Hydrobates microsoma*	48 / 42 / 0.05	26 / 23 / 0.05
Least tern	*Sterna antillarum*		
Long-tailed jaeger	*Stercorarius longicaudus*	2 / 2 / 0	1 / 1 / 0
Manx shearwater	*Puffinus puffinus*		
Marbled murrelet	*Brachyramphus marmoratus*		
Masked booby	*Sula dactylatra*		
Mew gull	*Larus canus*		
Mottled petrel	*Pterodroma inexpectata*		
Murphy's petrel	*Pterodroma ultima*	8 / 8 / 0.01	6 / 6 / 0.01
Nazca booby	*Sula granti*		
Northern fulmar	*Fulmarus glacialis*	5 / 5 / 0.01	1 / 1 / 0
Osprey	*Pandion haliaetus*		
Pacific loon	*Gavia pacifica*	75 / 49 / 0.09	22 / 15 / 0.04
Parakeet auklet	*Aethia psittacula*		
Parasitic jaeger	*Stercorarius parasiticus*		
Parkinson's petrel	*Procellaria parkinsoni*		
Pelagic cormorant	*Urile pelagicus*	6 / 1 / 0.01	6 / 1 / 0.01
Peregrine falcon	*Falco peregrinus*		
Pigeon guillemot	*Cepphus columba*	1 / 1 / 0	1 / 1 / 0
Pink-footed shearwater	*Ardenna creatopus*	39 / 20 / 0.05	12 / 6 / 0.02
Pomarine jaeger	*Stercorarius pomarinus*	31 / 25 / 0.04	18 / 14 / 0.03
Providence/Solander's petrel	*Pterodroma solandri*		
Red phalarope	*Phalaropus fulicaria*	1047 / 75 / 1.27	499 / 58 / 0.92
Red-billed tropicbird	*Phaethon aethereus*		
Red-footed booby	*Sula sula*		
Red-necked grebe	*Podiceps grisegena*		
Red-necked phalarope	*Phalaropus lobatus*	1993 / 40 / 2.42	12 / 4 / 0.02
Red-tailed tropicbird	*Pheathon rubricauda*		
Red-throated loon	*Gavia stellata*		
Rhinoceros auklet	*Cerorhinca monocerata*	83 / 37 / 0.1	43 / 19 / 0.08
Ring-billed gull	*Larus delawarensis*		
Royal tern	*Thalasseus maximus*		
Ruddy turnstone	*Arenaria interpres*		
Sabine's gull	*Xema sabini*	11 / 3 / 0.01	
Scripps's murrelet	*Synthliboramphus scrippsi*		
Short-tailed / Slender-billed shearwater	*Ardenna tenuirostris*		
Short-tailed albatross	*Phoebastria albatrus*		
Sooty shearwater	*Ardenna grisea*	993 / 171 / 1.2	157 / 15 / 0.29
South polar skua	*Stercorarius maccormicki*		
Stejneger's petrel	*Pterodroma longirostris*		
Surf scoter	*Melanitta perspicillata*	10 / 3 / 0.01	7 / 2 / 0.01
Thayer's gull	*Larus glaucoides thayeri*		
Tufted puffin	*Fratercula cirrhata*	3 / 3 / 0	
Unidentified albatross	(species group)		
Unidentified auklet	(species group)		

Unidentified booby	(species group)		
Unidentified cormorant	(species group)	1 / 1 / 0	1 / 1 / 0
Unidentified gull	(species group)	288 / 41 / 0.35	48 / 26 / 0.09
Unidentified jaeger	(species group)		
Unidentified large alcid	(species group)		
Unidentified loon	(species group)	1 / 1 / 0	1 / 1 / 0
Unidentified murre	(species group)		
Unidentified murrelet	(species group)		
Unidentified petrel	(species group)		
Unidentified phalarope	(species group)	21 / 2 / 0.03	20 / 1 / 0.04
Unidentified procellarid	(species group)		
Unidentified shearwater	(species group)		
Unidentified small alcid	(species group)		
Unidentified storm-petrel	(species group)		
Unidentified tern	(species group)		
Wedge-rumped storm-petrel	*Hydrobates tethys*		
Wedge-tailed shearwater	*Puffinus pacificus*		
Western grebe	*Aechmophorus occidentalis*		
Western gull	*Larus occidentalis*	275 / 191 / 0.33	181 / 127 / 0.33
Wilson's storm-petrel	*Oceanites oceanicus*		
Xantus's / Craveri's murrelet	(species group)		
Xantus's murrelet	*Synthliboramphus hypoleucus*		

Figure 4. Log_{10} density anomalies for select seabird species, core survey area, 1987–2025. A) sooty shearwater, B) pink-footed shearwater, C) black-footed albatross, D) Laysan albatross, E) Cook's petrel, and F) Leach's storm-petrel complex (includes unidentified and subspecies since 2017). The shearwaters, albatrosses, and petrels are migrant species to the California Current Ecosystem. Dashed lines indicate ± 1 s.d. of the long-term mean, and 'X' indicates years when no spring survey was conducted. A constant of 0.01 was added to each density prior to log_{10} transformation and the anomaly calculation.

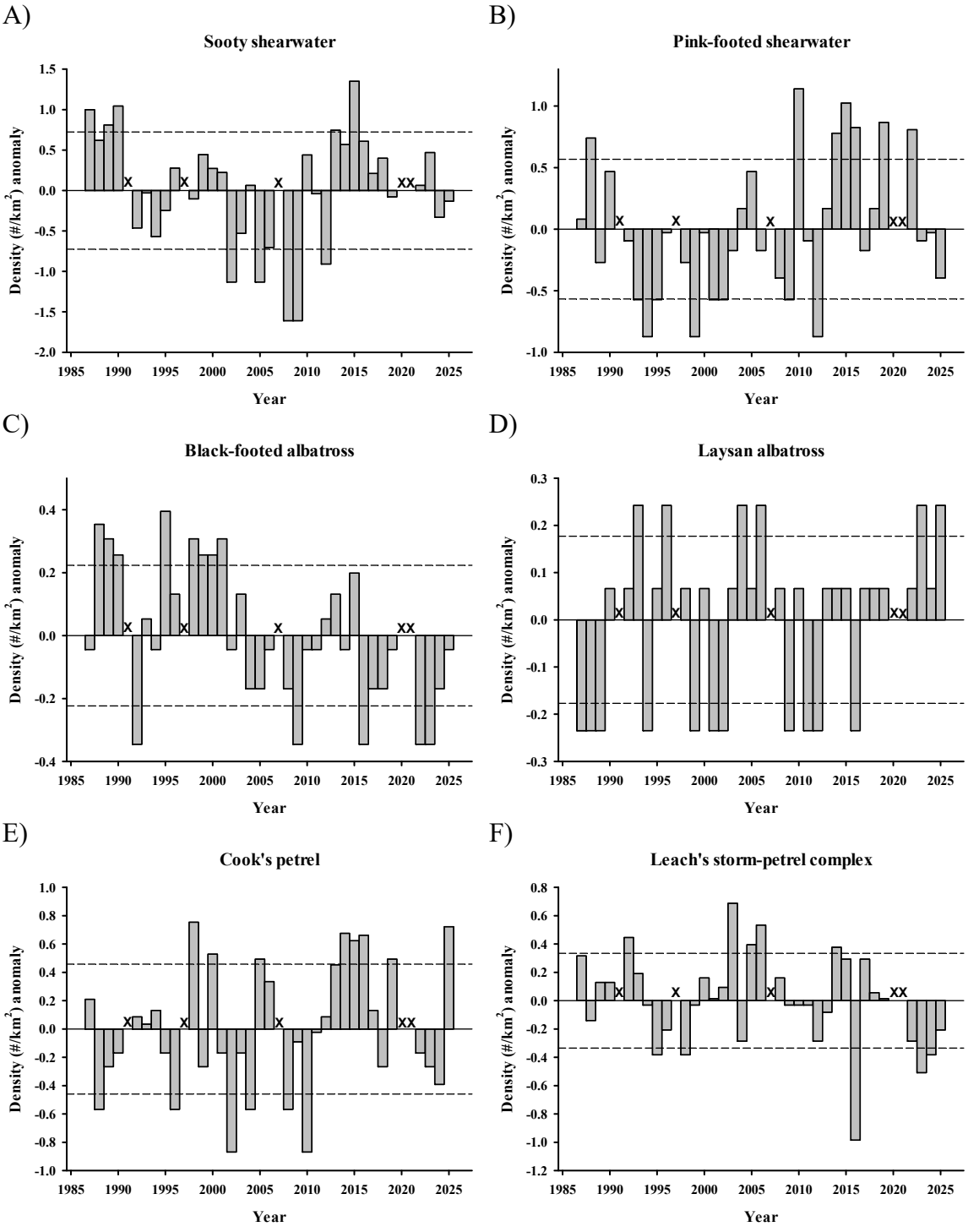


Figure 5. Log_{10} density anomalies for select alcid species, core area only, 1987–2025. A) Small alcids (Scripps' murrelet, Xantus'/Craveri's murrelet, and Guadalupe murrelet grouped), B) Cassin's auklet, C) common murre, and D) rhinoceros auklet. All breed in the California Current Ecosystem. The dashed lines indicate ± 1 s.d. of the long-term mean, and 'X' indicates years when no spring survey was conducted. A constant of 0.01 was added to each density prior to log_{10} transformation and the anomaly calculation.

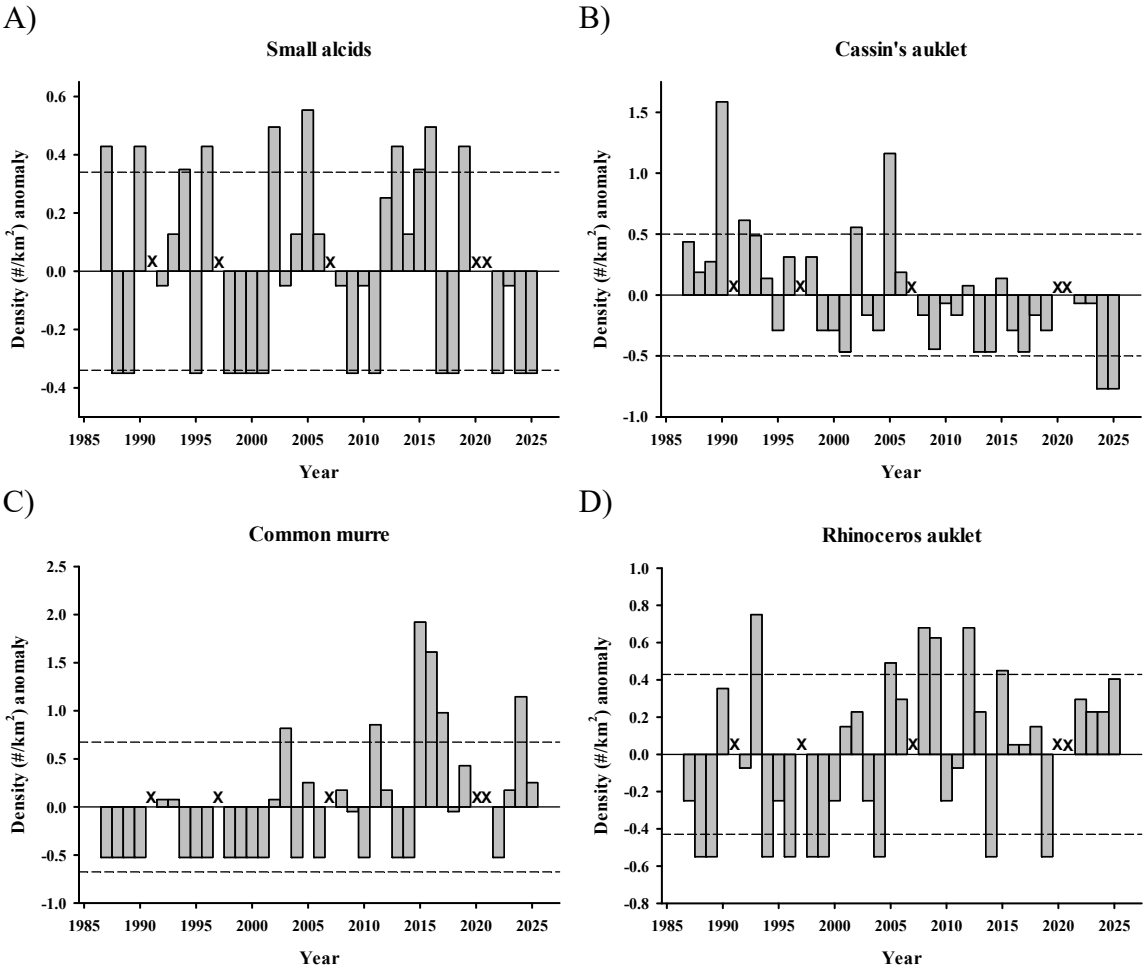


Figure 6. Log_{10} density anomalies for select locally-breeding seabird species, core area only, 1987–2025. A) Brandt's cormorant, B) brown pelican, C) western gull, D) Sabine's gull, and E) phalaropes. The dashed lines indicate ± 1 s.d. of the long-term mean, and 'X' indicates years when no spring survey was conducted. A constant of 0.01 was added to each density prior to log_{10} transformation and the anomaly calculation.

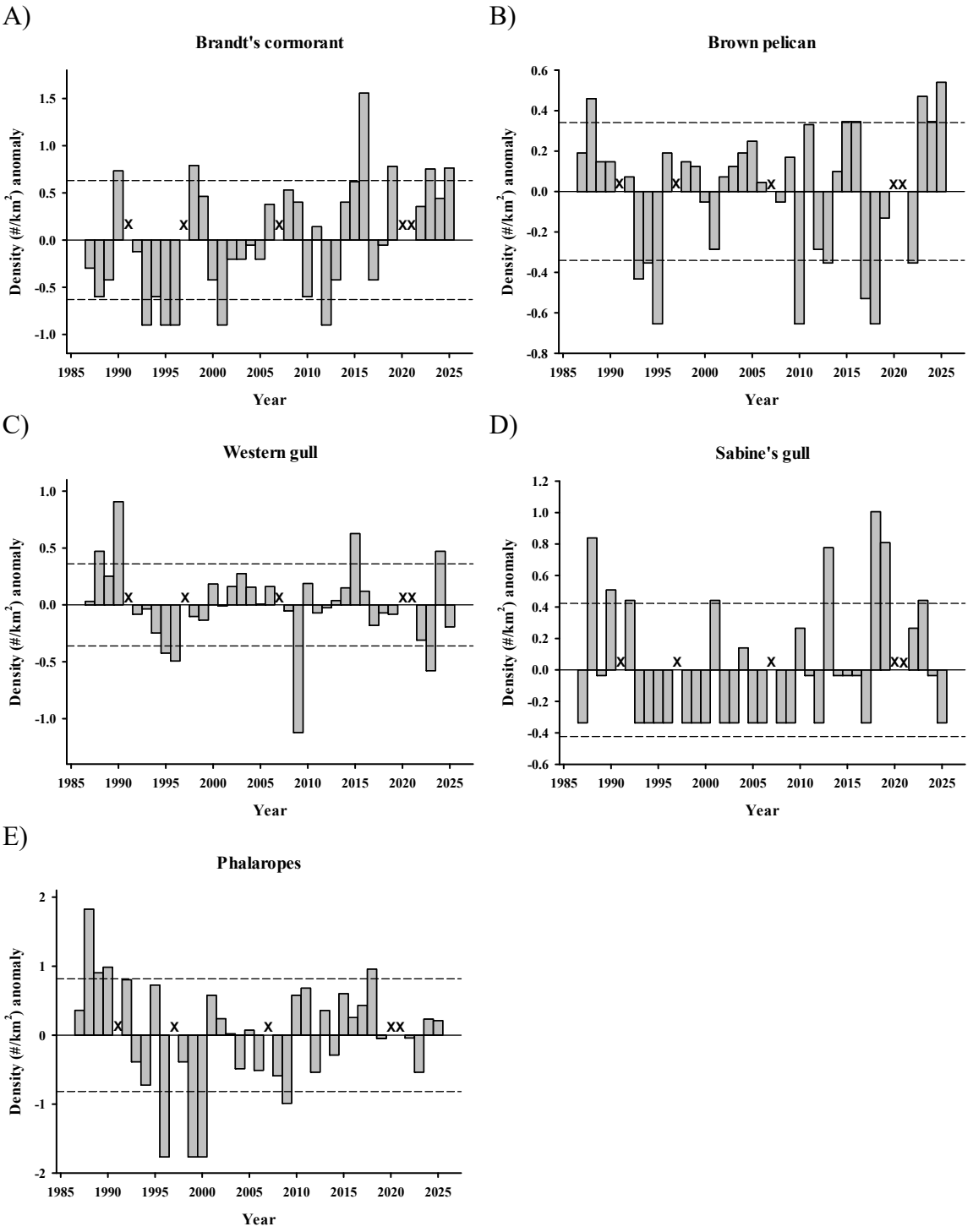


Table 3. Results of Spearman rank correlation of seabird density over time indicating trends. Bold: significance $p < 0.1$. N = 34 for all.

n = 34	rho	p-value
Sooty shearwater	-0.10	0.589
Pink-footed shearwater	**0.29**	**0.098**
Black-footed albatross	**-0.54**	**0.001**
Laysan albatross	0.27	0.123
Cook's petrel	0.19	0.287
Leach's storm-petrel complex	-0.27	0.116
Small alcids	-0.08	0.648
Cassin's auklet	**-0.60**	**0.000**
Common murre	**0.56**	**0.001**
Rhinoceros auklet	**0.35**	**0.046**
Brandt's cormorant	**0.47**	**0.005**
Brown pelican	0.06	0.745
Western gull	-0.17	0.339
Sabine's gull	0.21	0.242
Phalaropes	-0.11	0.530

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Appendix 1. List of bird species excluded from this summary. These species may or may not have been observed during the survey.

Common Name	Scientific Name
American Coot	*Fulica americana*
Black Oystercatcher	*Haematopus bachmani*
Black Skimmer	*Rynchops niger*
Black Tern	*Chlidonias niger*
Black Turnstone	*Arenaria melanocephala*
Black-throated gray warbler	*Setophaga nigrescens*
Blue-footed booby	*Sula nebouxii*
Brewer's Sparrow	*Spizella breweri*
Brown-headed cowbird	*Molothrus ater*
Bufflehead	*Bucephala albeola*
Chapman's Storm-Petrel	*Oceanodroma leucorhoa chapmani*
Eurasian collared dove	*Streptopelia decaocto*
European Starling	*Sturnus vulgaris*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Green Heron	*Butorides virescens*
Least Sandpiper	*Calidris minutilla*
Long-billed Curlew	*Numenius americanus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Mallard Duck	*Anas platyrhynchos*
Marbled Godwit	*Limosa fedoa*
Mourning Dove	*Zenaida macroura*
Red-Breasted Merganser	*Mergus serrator*
Ruddy Duck	*Oxyura jamaicensis*
Sanderling	*Calidris alba*
Savannah sparrow	*Passerculus sandwichensis*
Snow Goose	*Chen caerulescens*
Snowy Egret	*Egretta thula*
Townsend's warbler	*Setophaga townsendi*
Unidentified Bird	(species group)
Unidentified Dowitcher	
Unidentified Goose	(species group)
Unidentified Hummingbird	(species group)
Unidentified Passerine	(species group)
Unidentified raptor	(species group)
Unidentified Shorebird	(species group)
Wandering tattler	*Tringa incana*
Western Sandpiper	*Calidris mauri*
Whimbrel	*Numenius phaeopus*
White-Winged Scoter	*Melanitta fusca*
Willet	*Catoptrophorus semipalmatus*
Wilson's warbler	*Cardellina pusilla*
Yellow-Rumped Warbler	*Dendroica coronata*