Seabirds and ocean conditions from the CalCOFI/CCE-LTER Survey: Summer 2024 data report

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Cover photo: Two masked boobies along for the ride. Photo by Tammy Russell.

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 38 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 2024 summer CalCOFI/CCE-LTER cruise. We present 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 27 July to 11 August 2024 in the CalCOFI survey area. SST data were downloaded from the Multi-scale Ultra-high Resolution SST (MURSST) dataset (https://podaac.jpl.nasa.gov/dataset/MUR-JPL-L4-GLOB-v4.1), and wind (speed and direction) data were downloaded for NOAA/NDBC buoys (https://www.ndbc.noaa.gov/). Sea surface temperature anomalies (SSTa) averages for the same period are presented, with a baseline calculation period of 1991–2020. SSTa data were downloaded from the Optimal Interpolated SST (OISST) dataset (https://psl.noaa.gov/data/gridded/data.noaa.oisst.v2.highres.html). 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 species with warm- and cold-water affinities for the period 1987 through 2024, summer only. We defined species with warm-water affinity to include black-footed albatross (*Phoebastria nigripes*), black-vented shearwater (*Puffinus opisthomelas*), brown pelican (*Pelecanus occidentalis*) Cook's petrel (*Pterodroma cookii*), elegant tern (*Sterna elegans*), and a Leach's storm-petrel complex (Hyrenbach and Veit 2003). Since 2017 we have used a category for a complex of Leach's storm-petrels that includes all unidentified and newly-described species in a single category (Leach's storm-petrel *Hydrobates leucorhous*, Townsend's storm-petrel *H. socorroensis*, Ainley's storm-petrel *H. cheimomnestes*, and unidentified Leach's storm-petrel). Cold-water affinity species include Brandt's cormorant (*Urile penicillatus*), Buller's shearwater (*Ardenna bulleri*), Cassin's auklet (*Ptychoramphus aleuticus*), common murre (*Uria aalge*), pink-footed shearwater (*A. creatopus*), and sooty shearwater (*A. grisea*) (Hyrenbach and Veit 2003).

Results

Oceanographic conditions. The summer CalCOFI survey transited through an upwelling event north of Point Conception with cool water, meanwhile, the Southern California Bight experienced warmer ocean temperatures (Figure 1A). Both of these local conditions (upwelling in the northern part of the survey and warm water in the bight) are confirmed on the sea surface anomaly map (Figure 1B). Buoy data showed a consistent decline in water temperature after the start of the survey, and wind speed was consistently strong toward the southeast, which is upwelling-favorable conditions (Figure 2).

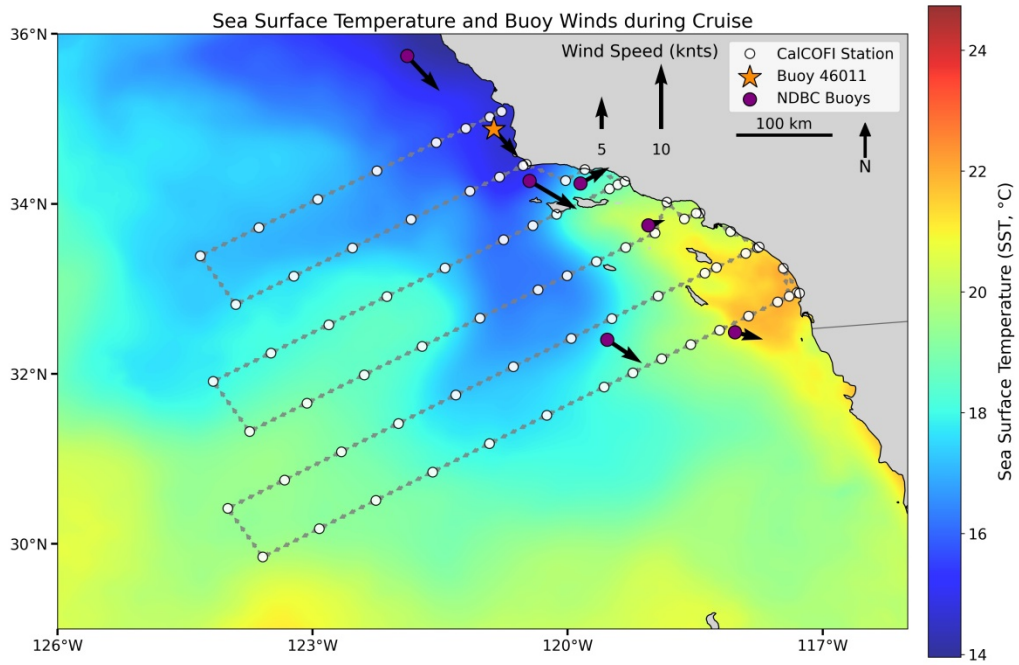
Surveying effort. A summary of survey effort is shown in Table 1; transects surveyed are shown in Figure 1. Summarized species observations for all species are shown in Table 2 (see Appendix 1 for exclusions). Survey effort over 16 days covered 1,957 km (587 km^2) of ocean habitat both within and north of the core survey area (Figure 3).

Seabirds. Density over time for the selected seabird species (listed above) was calculated and is shown as anomalies in Figures 4–6. Most of the species associated with warm water had above average density on this survey. Birds in the Leach's storm-petrel complex were present at an average density (Figure 4). Black-footed albatross were observed at above average density but within 1 s.d. of the mean. Very high densities of elegant terns were observed (highest in the time series), consistent with the continuing pattern of their northward range expansion. Black-vented shearwaters were also present at high densities, continuing an increasing trend since 2015. Brown pelican and Cook's petrel had above average density, nearly at 1 s.d. of the mean. Cold-

water affiliated species were mixed with above and below observed densities, but none were outside of 1 s.d. of the mean (Figure 5). Sooty shearwaters were present at near average density, while pink-footed shearwater was slightly below average. Cassin's auklets were also below average, but common murre was present in higher than average densities. Lastly, Brandt's cormorants were present in higher than average densities, almost to 1 s.d. Overall, seabird density of all species combined was near average (Figure 6).

Figure 1. Ocean conditions in the greater CalCOFI area for the period 27 July to 11 August 2024. 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. Baseline period: 1991–2020.

A)



B)

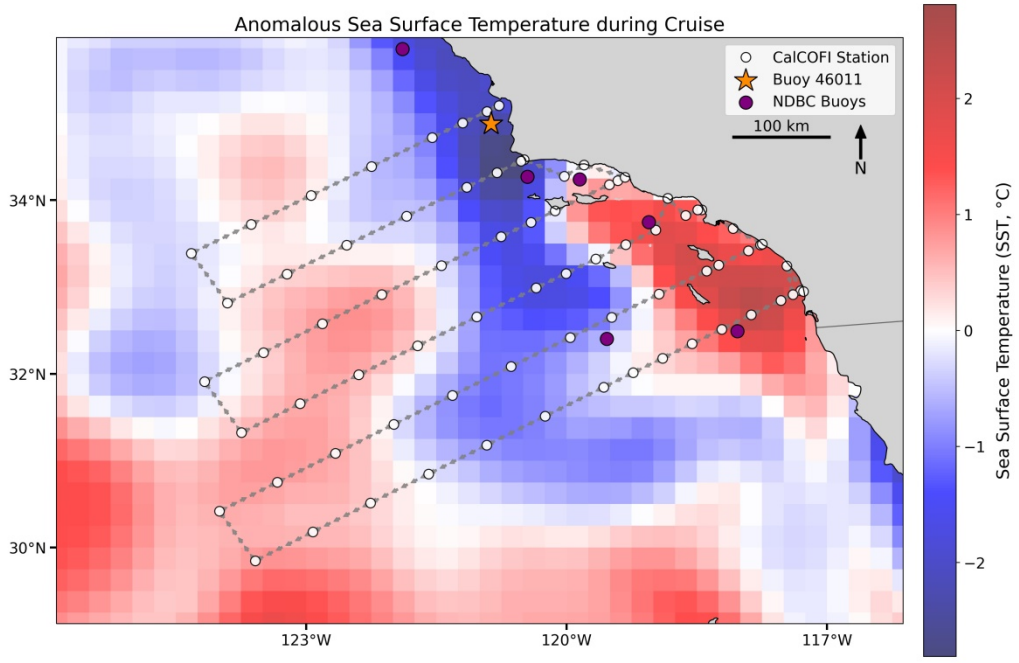


Figure 2. Daily SST (C°) and wind averages for the period 27 July to 11 August 2024 at NOAA/NDBC buoy 46011; location is marked in Figure 1 with an orange star. The beginning of the cruise is shown with a dashed vertical line. Bottom panel: arrow direction indicates the direction the wind is blowing (up = north) and the y-axis indicates wind speed scale in knots. Upwelling-favorable winds are strong winds to the southeast.

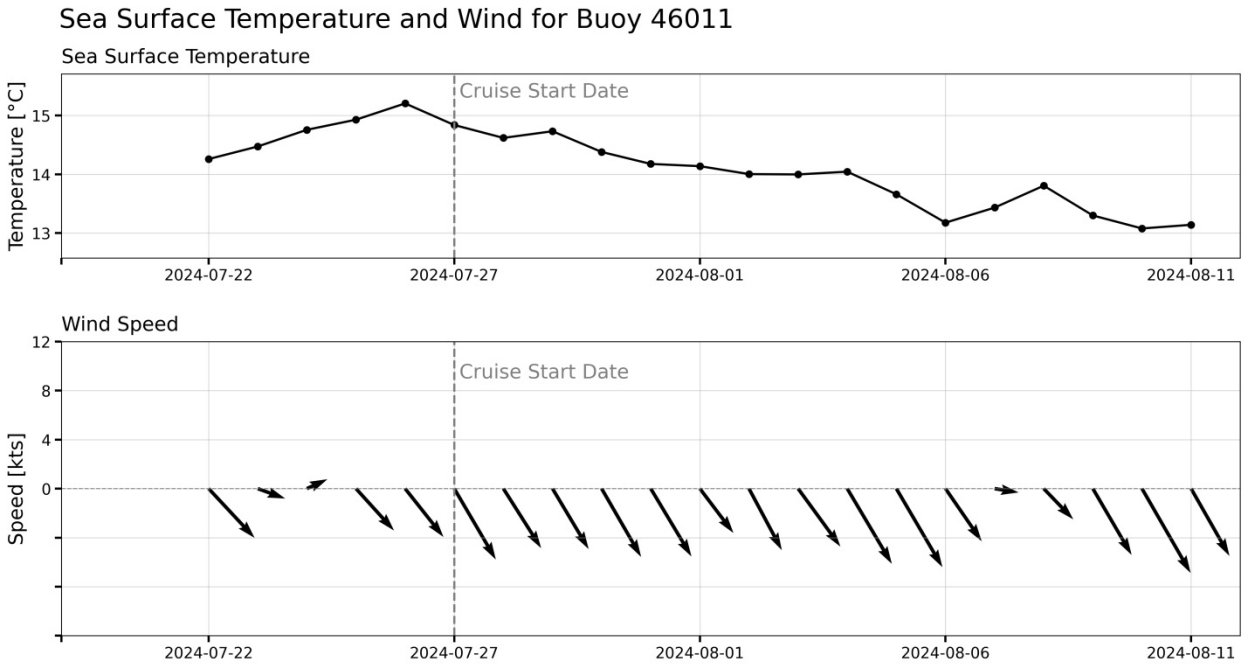


Table 1. Summary of survey effort and seabird statistics for the full survey area, summer 2024. All surveying took place within the core survey area (see Figure 3).

Summer 2024	Full survey area
Survey vessel	RV *Sally Ride*
Start date	7/27/2024
End date	8/11/2024
Number of survey days	16
Distance surveyed (km)	1,957
Area surveyed (km^2)	587
Number of bird species	42
Overall bird density (per km^2)	4.853
Total individuals counted	2,849

Figure 3. Transects sampled during the CalCOFI summer 2024 survey. The core study area is denoted with the box, and includes CalCOFI lines 93 (south) to 77 (north).

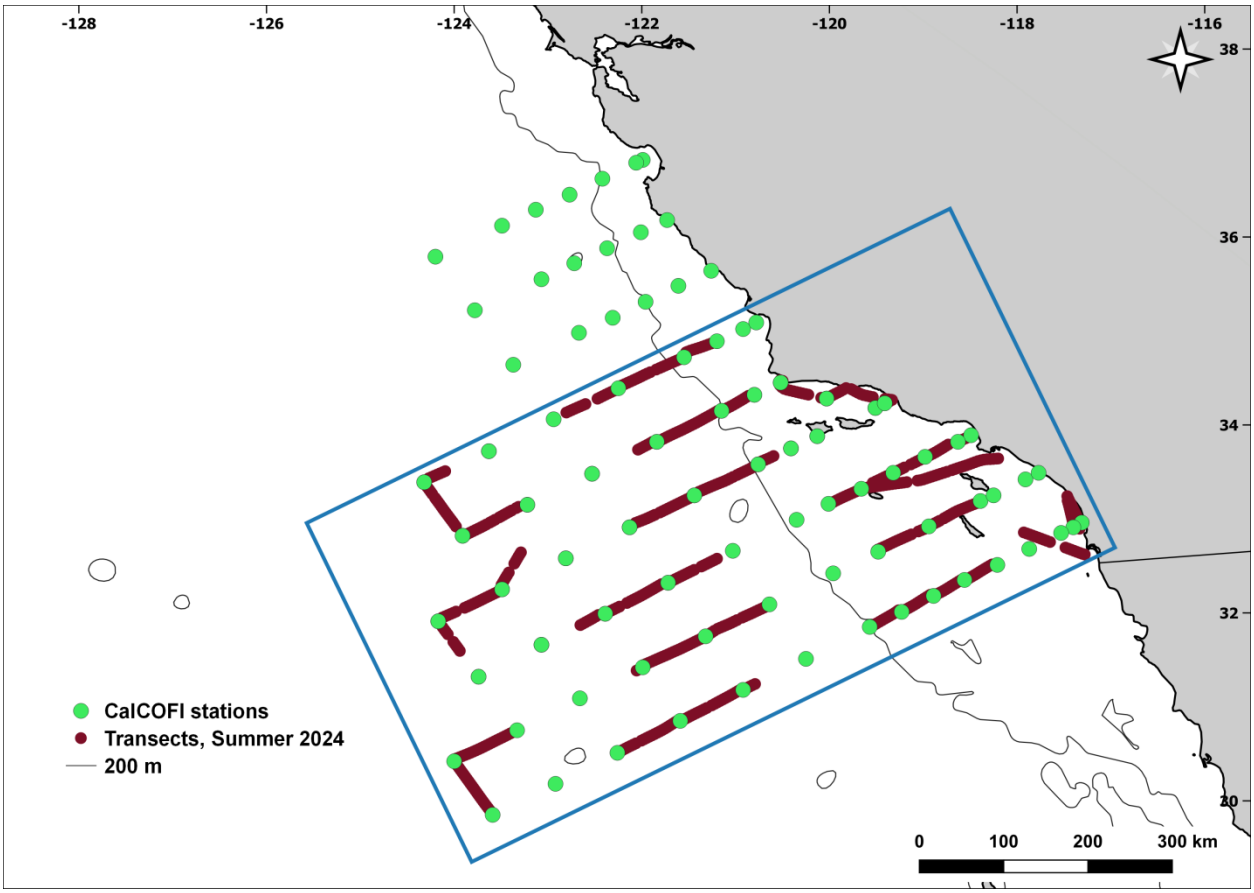


Table 2. Observations in summer 2024 by species in the full survey area (see Figure 3). Cell values: total number of individuals (ind.) / number of observations per species (obs.) / species density (dens.) in individuals per km^2.

Common Name	Scientific Name	Core area
American white pelican	*Pelecanus erythrorhynchos*	
Ancient murrelet	*Synthliboramphus antiquus*	
Arctic loon	*Gavia arctica*	
Arctic tern	*Sterna paradisaea*	
Ashy storm-petrel	*Hydrobates homochroa*	7 / 6 / 0.01
Black guillemot	*Cepphus grylle*	
Black scoter	*Melanitta americana*	
Black storm-petrel	*Hydrobates melania*	4 / 4 / 0.01
Black-footed albatross	*Phoebastria nigripes*	22 / 16 / 0.04
Black-legged kittiwake	*Rissa tridactyla*	
Black-vented shearwater	*Puffinus opisthomelas*	638 / 48 / 1.09
Bonaparte's gull	*Chroicocephalus philadelphia*	
Brandt's cormorant	*Urile penicillatus*	12 / 12 / 0.02
Brant	*Branta bernicla*	
Brown booby	*Sula leucogaster*	2 / 2 / 0
Brown noddy	*Anous stolidus*	
Brown pelican	*Pelecanus occidentalis*	120 / 35 / 0.2
Buller's shearwater	*Ardenna bulleri*	15 / 7 / 0.03
California gull	*Larus californicus*	
Caspian tern	*Hydroprogne caspia*	19 / 11 / 0.03
Cassin's auklet	*Ptychoramphus aleuticus*	6 / 4 / 0.01
Clark's grebe	*Aechmophorus clarkii*	
Common loon	*Gavia immer*	
Common murre	*Uria aalge*	27 / 3 / 0.05
Common tern	*Sterna hirundo*	18 / 10 / 0.03
Cook's petrel	*Pterodroma cookii*	164 / 88 / 0.28
Craveri's murrelet	*Synthliboramphus craveri*	
Dark shearwater	(species group)	
Dark-rumped petrel	*Pterodroma phaeopygia sandwichensis*	
Double-crested cormorant	*Nannopterum auritum*	2 / 2 / 0
Eared grebe	*Podiceps nigricollis*	
Elegant tern	*Thalasseus elegans*	494 / 109 / 0.84
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*	
Glaucous-winged/Western hybrid gull		
Guadalupe murrelet	*Synthliboramphus hypoleucus*	4 / 4 / 0.01
Hawaiian petrel	*Pterodroma sandwichensis*	1 / 1 / 0
Heermann's gull	*Larus heermanni*	2 / 2 / 0
Herring gull	*Larus argentatus*	
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*	
Leach's storm-petrel complex	(species group)	226 / 209 / 0.39
Least storm-petrel	*Hydrobates microsoma*	10 / 10 / 0.02
Least tern	*Sterna antillarum*	
Long-tailed jaeger	*Stercorarius longicaudus*	1 / 1 / 0
Manx shearwater	*Puffinus puffinus*	
Marbled murrelet	*Brachyramphus marmoratus*	
Masked booby	*Sula dactylatra*	4 / 3 / 0.01
Mew gull	*Larus canus*	
Mottled petrel	*Pterodroma inexpectata*	
Murphy's petrel	*Pterodroma ultima*	
Nazca booby	*Sula granti*	2 / 2 / 0
Northern fulmar	*Fulmarus glacialis*	
Osprey	*Pandion haliaetus*	
Pacific loon	*Gavia pacifica*	
Parakeet auklet	*Aethia psittacula*	
Parasitic jaeger	*Stercorarius parasiticus*	
Parkinson's petrel	*Procellaria parkinsoni*	
Pelagic cormorant	*Urile pelagicus*	
Peregrine falcon	*Falco peregrinus*	
Pigeon guillemot	*Cepphus columba*	
Pink-footed shearwater	*Ardenna creatopus*	117 / 50 / 0.2
Pomarine jaeger	*Stercorarius pomarinus*	4 / 4 / 0.01
Providence/Solander's petrel	*Pterodroma solandri*	10 / 2 / 0.02
Red phalarope	*Phalaropus fulicaria*	1 / 1 / 0
Red-billed tropicbird	*Phaethon aethereus*	1 / 1 / 0
Red-footed booby	*Sula sula*	
Red-necked grebe	*Podiceps grisegena*	29 / 4 / 0.05
Red-necked phalarope	*Phalaropus lobatus*	
Red-tailed tropicbird	*Pheathon rubricauda*	

Red-throated loon	*Gavia stellata*	2 / 1 / 0
Rhinoceros auklet	*Cerorhinca monocerata*	
Ring-billed gull	*Larus delawarensis*	5 / 4 / 0.01
Royal tern	*Thalasseus maximus*	
Ruddy turnstone	*Arenaria interpres*	4 / 4 / 0.01
Sabine's gull	*Xema sabini*	8 / 5 / 0.01
Scripps's murrelet	*Synthliboramphus scrippsi*	
Short-tailed / Slender-billed shearwater	*Ardenna tenuirostris*	
Short-tailed albatross	*Phoebastria albatrus*	
Sooty shearwater	*Ardenna grisea*	586 / 106 / 1
South polar skua	*Stercorarius maccormicki*	1 / 1 / 0
Stejneger's petrel	*Pterodroma longirostris*	
Surf scoter	*Melanitta perspicillata*	
Thayer's gull	*Larus glaucoides thayeri*	
Townsend's storm-petrel	*Hydrobates socorroensis*	
Tufted puffin	*Fratercula cirrhata*	
Unidentified albatross	(species group)	
Unidentified auklet	(species group)	
Unidentified booby	(species group)	
Unidentified cormorant	(species group)	
Unidentified gull	(species group)	2 / 2 / 0
Unidentified jaeger	(species group)	1 / 1 / 0
Unidentified large alcid	(species group)	
Unidentified loon	(species group)	
Unidentified murre	(species group)	
Unidentified murrelet	(species group)	4 / 2 / 0.01
Unidentified petrel	(species group)	
Unidentified phalarope	(species group)	
Unidentified procellarid	(species group)	
Unidentified shearwater	(species group)	
Unidentified small alcid	(species group)	
Unidentified storm-petrel	(species group)	4 / 4 / 0.01
Unidentified tern	(species group)	
Wedge-rumped storm-petrel	*Hydrobates tethys*	
Wedge-tailed shearwater	*Puffinus pacificus*	
Western grebe	*Aechmophorus occidentalis*	
Western gull	*Larus occidentalis*	266 / 184 / 0.45
Wilson's storm-petrel	*Oceanites oceanicus*	
Xantus's / Craveri's murrelet	(species group)	2 / 2 / 0
Xantus's murrelet	*Synthliboramphus hypoleucus*	

Figure 4. Log_{10} density anomalies for species with warm-water affinities, core survey area, 1987–2024. A) black-footed albatross, B) black-vented shearwater, C) brown pelican, D) Cook's petrel, E) elegant tern, and F) Leach's storm-petrel complex (includes unidentified and subspecies since 2017). The dashed lines indicate ± 1 s.d. of the long-term mean, and 'X' indicates years when no summer survey was conducted. A constant of 0.01 was added to each density prior to log_{10} transformation and the anomaly calculation.

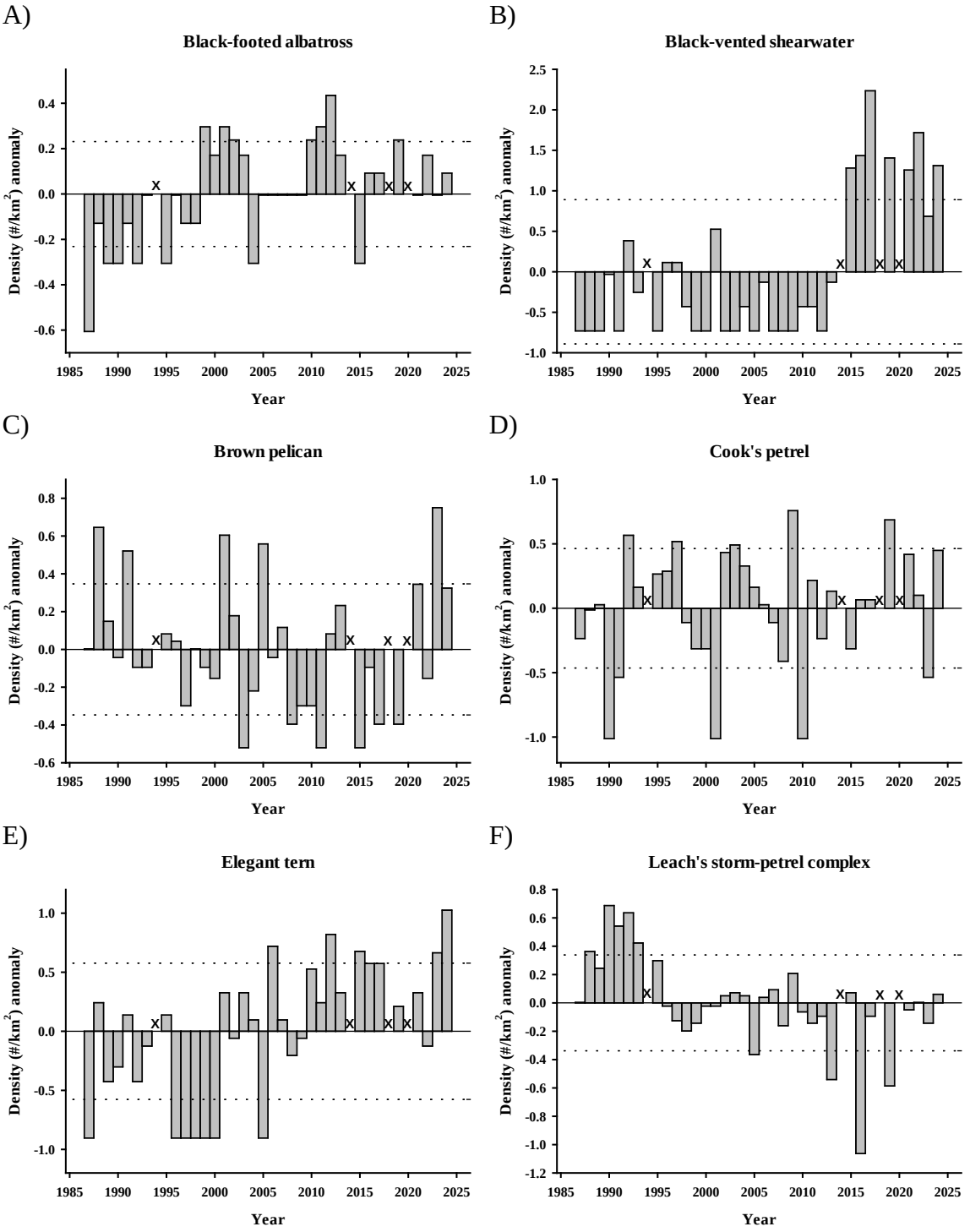


Figure 5. Log_{10} density anomalies for species with cold-water affinities, core area only, 1987–2024. A) Brandt's cormorant, B) Cassin's auklet, C) common murre, D) pink-footed shearwater, and E) sooty shearwater. The dashed lines indicate ± 1 s.d. of the long-term mean, and 'X' indicates years when no summer survey was conducted. A constant of 0.01 was added to each density prior to log_{10} transformation and the anomaly calculation.

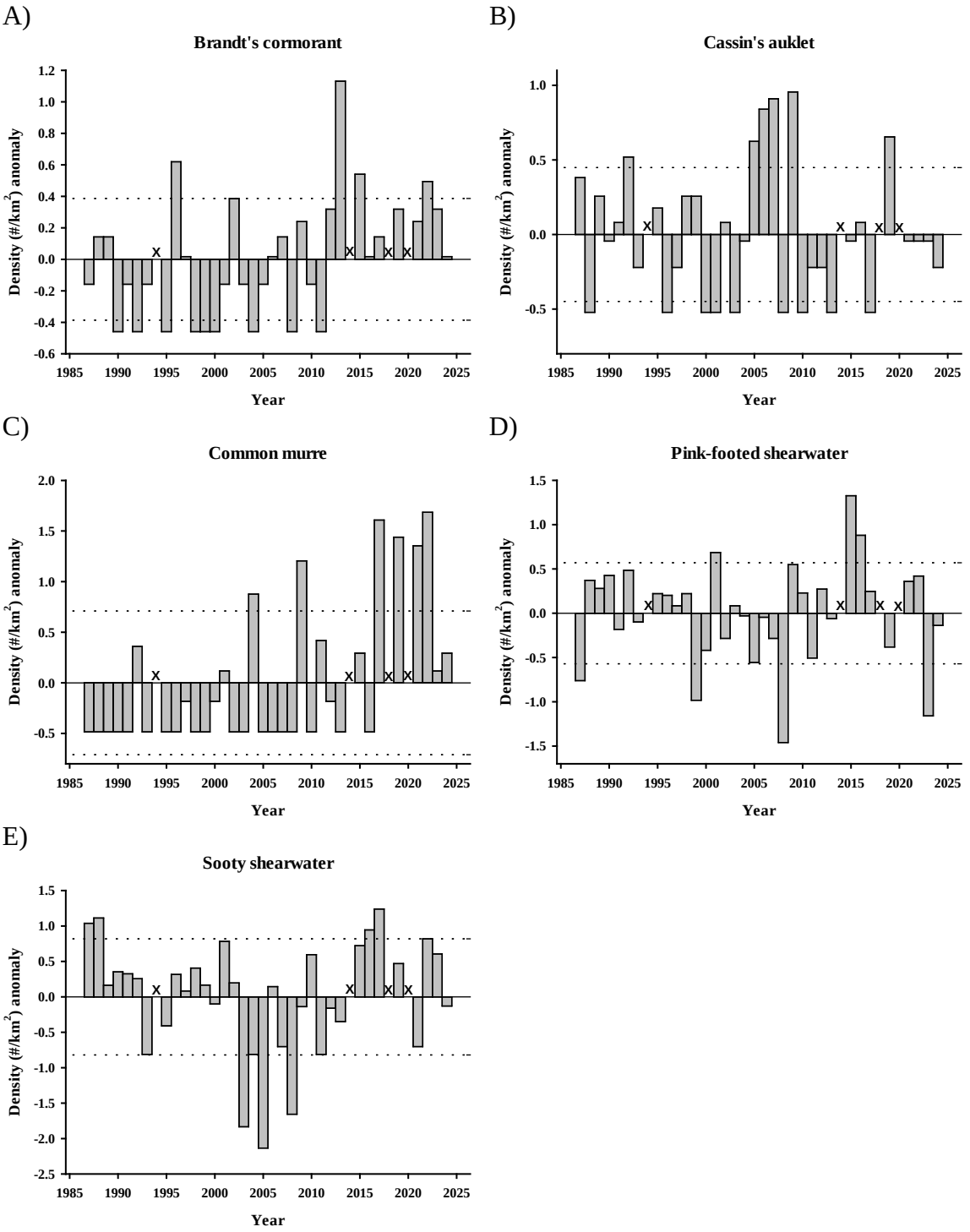
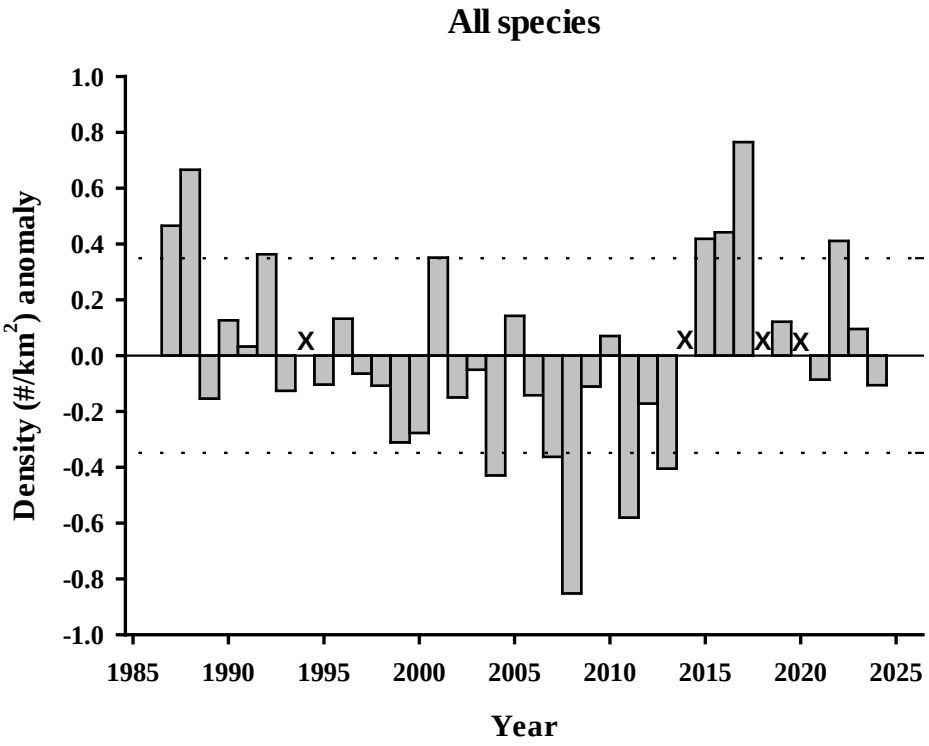


Figure 6. Log_{10} density anomalies in the summer for all species in the core area only, 1987–2024. The dashed lines indicate ± 1 s.d. of the long-term mean, and 'X' indicates years when no summer survey was conducted. A constant of 0.01 was added prior to log_{10} transformation and the anomaly calculation.



References

Hyrenbach, D.K., and R.R. Veit. 2003. Ocean warming and seabird communities of the Southern California Current System (1987–98): response at multiple temporal scales. Deep-Sea Research Part II 50:2537–2565.

Santora, J.A. and W.J. Sydeman. 2015. Persistence of hotspots and variability of seabird species richness and abundance in the southern California Current. Ecosphere 6:214.

Santora, J.A., W.J. Sydeman, I.D. Schroeder, J.C. Field, R.R. Miller, and B.K. Wells. 2017. Persistence of trophic hotspots and relation to human impacts within an upwelling marine ecosystem. Ecological Applications 27:560–574.

Sydeman, W.J., S.A. Thompson, J.A. Santora, J.A. Koslow, R. Goericke, and M.D. Ohman. 2015. Climate-ecosystem change off southern California: Time-dependent seabird predator-prey numerical responses. Deep-Sea Research Part II 112:158–170.

Veit, R.R., P. Pyle, and J.A. McGowan. 1996. Ocean warming and long-term change in pelagic bird abundance within the California Current System. Marine Ecology Progress Series 139:11–18.

Velarde, E., E. Ezcurra, M.H. Horn, and R.T. Patton. 2015. Warm oceanographic anomalies and fishing pressure drive seabird nesting north. Science Advances 1:e1400210.

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*