

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

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30 April 2024

Cover photo: Laysan albatross; 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 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 spring CalCOFI/CCE-LTER cruise. We present data on survey effort as well as summary information on seabird abundance, expressed at density (birds/km²), and oceanographic conditions during the survey period.

Methods

Seabird observations. Observations of seabirds are made continuously during daylight ship transits between oceanographic/plankton sampling stations. The observer, located on the 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 (km²) surveyed. Density is expressed by log₁₀ function; a constant of 0.01 was added to each species’ density prior to transformation. Anomalies of log₁₀-transformed density over time are shown for species with warm- and cold-water affinities for the period 1987 through 2024, spring only. We defined species with warm-water affinity to include black-footed albatross

(*Phoebastria nigripes*), black-vented shearwater (*Puffinus opisthomelas*), Cook's petrel (*Pterodroma cookii*), elegant tern (*Sterna elegans*), pink-footed shearwater (*Puffinus creatopus*), 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 *Oceanodroma leucorhoa*, Townsend's storm-petrel *O. socorroensis*, Ainley's storm-petrel *Hydrobates cheimomnestes*, and unidentified Leach's storm-petrel). Cold-water affinity species include Bonaparte's gull (*Larus philadelphia*), common murre (*Uria aalge*), rhinoceros auklet (*Cerorhinca monocerata*), Sabine's gull (*Larus sabini*), and sooty shearwater (*Ardenna grisea*) (Hyrenbach and Veit 2003).

Oceanographic conditions. We present sea surface temperature (SST; C°) and wind averages for the period 26 March to 19 April 2024 in the greater 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=46025).

Results

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 25 days covered 2,468 km (740 km²) of ocean habitat both within and north of the core survey area (Figure 1).

Seabirds. Density over time for the selected seabird species (listed above) was calculated and is shown as anomalies in Figures 2–4. Among the species associated with warm water, pink-footed shearwater was present at an average density (Figure 2). Black-footed albatross, Cook's petrel, and black-vented shearwater were observed at low density but within 1 s.d. of the mean while density of birds in the Leach's storm-petrel complex was slightly lower than 1 s.d. of the mean. Very high densities of elegant terns were observed (second highest in the time series), consistent with the continuing pattern of their northward range expansion. Cold-water affiliated species generally showed densities near or above average (Figure 3). Bonaparte's gull and Sabine's gull were present at near average density, while rhinoceros auklet was above average but within 1 s.d. of the mean. Common murre was present in very high densities compared to normal. Lastly, sooty shearwaters were present at near-normal but slightly lower than average density. Overall, seabird density of all species combined was average (Figure 4).

Oceanographic conditions. The spring CalCOFI survey transited a wide range of water temperatures, with cooler nearshore waters along the coast of Central California, indicating upwelling, and warm waters offshore in Southern California (Figure 5). During the time of this cruise, ocean conditions were slightly warmer though the nearshore area was cooler than normal (Figure 6). With the predicted shift out of the recent El Niño conditions, SST should start to

return to normal. In the California Bight region, temperatures at the beginning of the cruise were dynamic with a sharp increase in temperature on March 28 and a shift in win direction and speed, but quickly stabilized and remained fairly consistent for the rest of the cruise (Figure 7).

Table 1. Summary of survey effort and seabird statistics for the full survey area, spring 2024.

Spring 2024	Full survey area
Survey vessel	RV <i>Bell M. Shimada</i>
Start date	3/26/2024
End date	4/19/2024
Number of survey days	25
Distance surveyed (km)	2,468
Area surveyed (km ²)	740
Number of bird species	41
Overall bird density (per km ²)	11.679
Total individuals counted	8,648

Figure 1. Transects sampled during the CalCOFI spring 2024 survey. The core study area is denoted with the box, and includes CalCOFI lines 93 (south) to 77 (north).

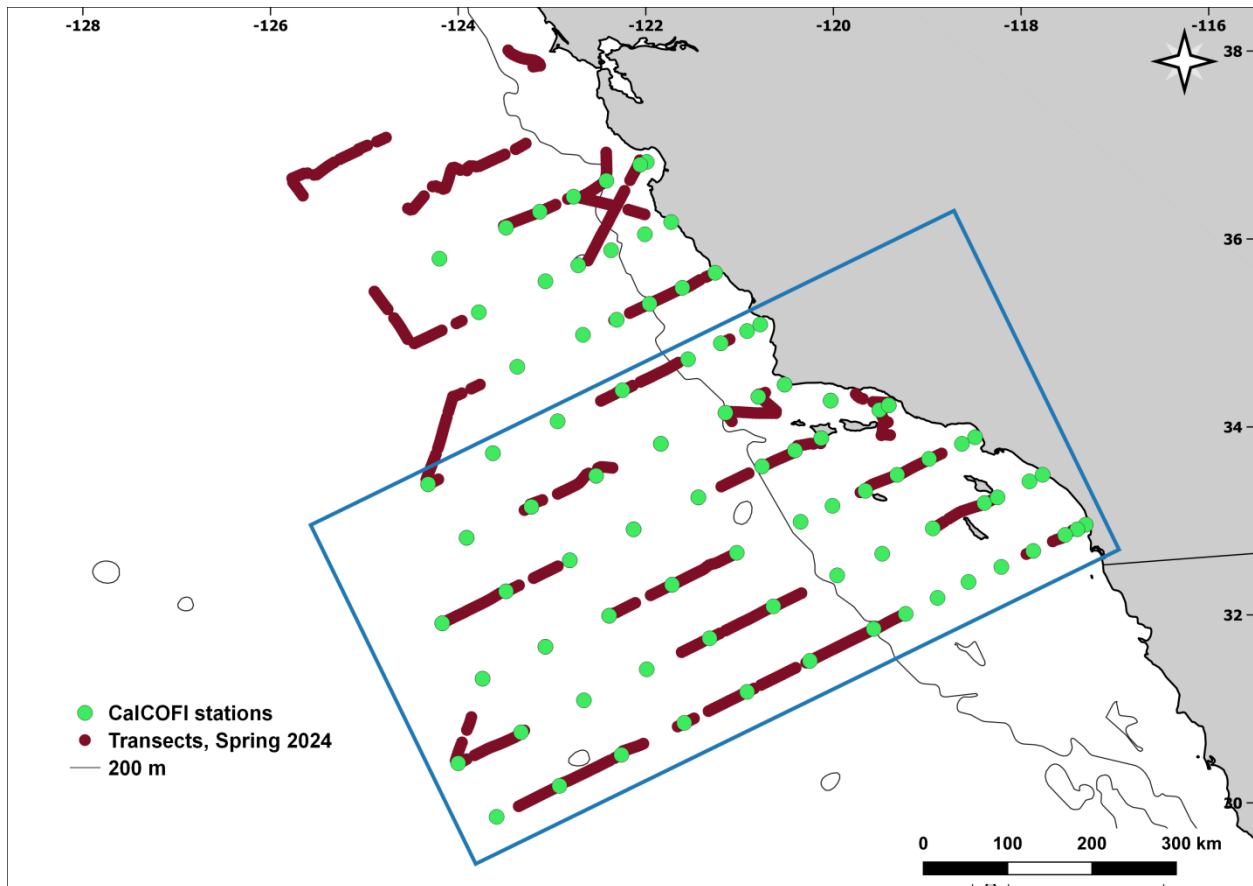


Table 2. Observations in spring 2024 by species in the core and core+extended areas (see Figure 1). Cell values: total number of individuals (ind.) / number of observations per species (obs.) / species density (dens.) in individuals per km².

Common Name	Scientific Name	Core area	Core + extended area
American White Pelican	<i>Pelecanus erythrorhynchos</i>		
Ancient Murrelet	<i>Synthliboramphus antiquus</i>	1 / 1 / 0	1 / 1 / 0
Arctic Loon	<i>Gavia arctica</i>		
Arctic Tern	<i>Sterna paradisaea</i>		
Ashy Storm-Petrel	<i>Oceanodroma homochroa</i>	3 / 1 / 0.01	4 / 2 / 0.01
Black guillemot	<i>Cephus grylle</i>		
Black Scoter	<i>Melanitta nigra</i>		
Black Storm-Petrel	<i>Oceanodroma melania</i>		
Black-Footed Albatross	<i>Phoebastria nigripes</i>	8 / 7 / 0.02	25 / 16 / 0.03
Black-Legged Kittiwake	<i>Rissa tridactyla</i>	1 / 1 / 0	4 / 4 / 0.01
Black-Vented Shearwater	<i>Puffinus opisthomelas</i>	3 / 1 / 0.01	3 / 1 / 0
Bonaparte's Gull	<i>Larus philadelphia</i>	94 / 26 / 0.19	138 / 41 / 0.19
Brandt's Cormorant	<i>Phalacrocorax penicillatus</i>	100 / 44 / 0.21	107 / 49 / 0.14
Brant	<i>Branta bernicla</i>		
Brown Booby	<i>Sula leucogaster</i>		
Brown Noddy	<i>Anous stolidus</i>		
Brown Pelican	<i>Pelecanus occidentalis</i>	139 / 35 / 0.29	155 / 42 / 0.21
Buller's Shearwater	<i>Puffinus bulleri</i>		
California Gull	<i>Larus californicus</i>	66 / 37 / 0.14	144 / 77 / 0.19
Caspian Tern	<i>Sterna caspia</i>		
Cassin's Auklet	<i>Ptychoramphus aleuticus</i>	2 / 1 / 0	7 / 4 / 0.01
Clark's Grebe	<i>Aechmophorus clarkii</i>		
Common Loon	<i>Gavia immer</i>	1 / 1 / 0	1 / 1 / 0
Common Murre	<i>Uria aalge</i>	220 / 100 / 0.46	4897 / 327 / 6.61
Common Tern	<i>Sterna hirundo</i>	2 / 1 / 0	5 / 3 / 0.01
Cook's Petrel	<i>Pterodroma cookii</i>	8 / 5 / 0.02	15 / 12 / 0.02
Craveri's Murrelet	<i>Synthliboramphus craveri</i>		
Dark Shearwater	(species group)		
Dark-Rumped Petrel	<i>Pterodroma phaeopygia sandwichensis</i>		
Double-Crested Cormorant	<i>Phalacrocorax auritus</i>		
Eared Grebe	<i>Podiceps nigricollis</i>		
Elegant Tern	<i>Sterna elegans</i>	312 / 31 / 0.65	321 / 34 / 0.43
Flesh-Footed Shearwater	<i>Puffinus carneipes</i>		
Fork-Tailed Storm-Petrel	<i>Oceanodroma furcata</i>		
Forster's Tern	<i>Sterna forsteri</i>		
Franklin's Gull	<i>Larus pipixcan</i>		
Glaucous Gull	<i>Larus hyperboreus</i>		
Glaucous-Winged Gull	<i>Larus glaucescens</i>		
Glaucous-winged/Western Hybrid Gull			
Guadalupe Murrelet	<i>Synthliboramphus hypoleucus</i>		

Hawaiian Petrel	<i>Pterodroma sandwichensis</i>		
Heermann's Gull	<i>Larus heermanni</i>	17 / 6 / 0.04	18 / 7 / 0.02
Herring Gull	<i>Larus argentatus</i>	4 / 3 / 0.01	8 / 7 / 0.01
Horned Puffin	<i>Fratercula corniculata</i>		
Hybrid Gull	(species group)		
Juan Fernandez Petrel	<i>Pterodroma externa</i>		
Kelp Gull	<i>Larus dominicanus</i>		
Kermadec Petrel	<i>Pterodroma neglecta</i>		
Laughing Gull	<i>Larus atricilla</i>		
Laysan Albatross	<i>Phoebastria immutabilis</i>	4 / 4 / 0.01	19 / 7 / 0.03
Leach's Storm-Petrel Complex	(species group)	15 / 7 / 0.03	15 / 7 / 0.02
Least Storm-Petrel	<i>Oceanodroma microsoma</i>		
Least Tern	<i>Sterna antillarum</i>		
Long-Tailed Jaeger	<i>Stercorarius longicaudus</i>		
Manx Shearwater	<i>Puffinus puffinus</i>		
Marbled Murrelet	<i>Brachyramphus marmoratus</i>		
Masked Booby	<i>Sula dactylatra</i>		
Mew Gull	<i>Larus canus</i>		
Mottled Petrel	<i>Pterodroma inexpectata</i>		
Murphy's Petrel	<i>Pterodroma ultima</i>		3 / 3 / 0
Nazca Booby	<i>Sula granti</i>		
Northern Fulmar	<i>Fulmarus glacialis</i>	1 / 1 / 0	5 / 4 / 0.01
Osprey	<i>Pandion haliaetus</i>		
Pacific Loon	<i>Gavia pacifica</i>	39 / 19 / 0.08	47 / 25 / 0.06
Parakeet Auklet	<i>Aethia psittacula</i>		1 / 1 / 0
Parasitic Jaeger	<i>Stercorarius parasiticus</i>	2 / 1 / 0	2 / 1 / 0
Parkinson's Petrel	<i>Procellaria parkinsoni</i>		
Pelagic Cormorant	<i>Phalacrocorax pelagicus</i>	3 / 2 / 0.01	3 / 2 / 0
Peregrine Falcon	<i>Falco peregrinus</i>		
Pigeon Guillemot	<i>Cephus columba</i>		1 / 1 / 0
Pink-Footed Shearwater	<i>Puffinus creatopus</i>	31 / 20 / 0.06	44 / 30 / 0.06
Pomarine Jaeger	<i>Stercorarius pomarinus</i>	10 / 8 / 0.02	14 / 12 / 0.02
Red Phalarope	<i>Phalaropus fulicaria</i>	456 / 35 / 0.94	571 / 51 / 0.77
Red-Billed Tropicbird	<i>Phaethon aethereus</i>		
Red-Footed Booby	<i>Sula sula</i>		
Red-Necked Grebe	<i>Podiceps grisegena</i>		
Red-Necked Phalarope	<i>Phalaropus lobatus</i>	26 / 2 / 0.05	246 / 20 / 0.33
Red-Tailed Tropicbird	<i>Phaethon rubricauda</i>		
Red-Throated Loon	<i>Gavia stellata</i>		
Rhinoceros Auklet	<i>Cerorhinca monocerata</i>	22 / 13 / 0.05	70 / 40 / 0.09
Ring-Billed Gull	<i>Larus delawarensis</i>		
Royal Tern	<i>Sterna maxima</i>		
Ruddy Turnstone	<i>Arenaria interpres</i>		
Sabine's Gull	<i>Larus sabini</i>	3 / 1 / 0.01	11 / 7 / 0.01
Scripps's murrelet	<i>Synthliboramphus scrippsi</i>		
Short-Tailed / Slender-Billed Shearwater	<i>Puffinus tenuirostris</i>		
Short-Tailed Albatross	<i>Phoebastria albatrus</i>		

Solander's Petrel	<i>Pterodroma solandri</i>		
Sooty Shearwater	<i>Puffinus griseus</i>	85 / 25 / 0.18	735 / 127 / 0.99
South Polar Skua	<i>Stercorarius maccormicki</i>		
Stejneger's Petrel	<i>Pterodroma longirostris</i>		
Surf Scoter	<i>Melanitta perspicillata</i>		1 / 1 / 0
Thayer's Gull	<i>Larus thayeri</i>		
Tufted Puffin	<i>Fratercula cirrhata</i>		4 / 3 / 0.01
Unidentified Albatross	(species group)		
Unidentified Auklet	(species group)		
Unidentified Booby	(species group)		
Unidentified Cormorant	(species group)		
Unidentified Duck	(species group)		
Unidentified Grebe	(species group)		
Unidentified Gull	(species group)	55 / 16 / 0.11	187 / 23 / 0.25
Unidentified Jaeger	(species group)		
Unidentified Large Alcid	(species group)		
Unidentified Loon	(species group)		
Unidentified Murre	(species group)		
Unidentified Murrelet	(species group)		
Unidentified Petrel	(species group)		
Unidentified Phalarope	(species group)		
Unidentified Procellarid	(species group)		
Unidentified Shearwater	(species group)		
Unidentified Skua	(species group)		
Unidentified Small Alcid	(species group)		1 / 1 / 0
Unidentified Storm-Petrel	(species group)		
Unidentified Tern	(species group)	1 / 1 / 0	1 / 1 / 0
Unidentified Tropicbird	(species group)		
Wedge-Rumped Storm-Petrel	<i>Oceanodroma tethys</i>		
Wedge-Tailed Shearwater	<i>Puffinus pacificus</i>		
Western Grebe	<i>Aechmophorus occidentalis</i>		
Western Gull	<i>Larus occidentalis</i>	755 / 101 / 1.56	812 / 146 / 1.1
Wilson's Storm-Petrel	<i>Oceanites oceanicus</i>		
Xantus's / Craveri's Murrelet	(species group)	2 / 1 / 0	2 / 1 / 0
Xantus's Murrelet	<i>Synthliboramphus hypoleucus</i>		

Figure 2. Log₁₀ density anomalies for species with warm-water affinities, core survey area, 1987–2024. A) black-footed albatross, B) black-vented shearwater, C) Cook’s petrel, D) elegant tern, E) Leach’s storm-petrel complex (includes unidentified and subspecies since 2017), and F) pink-footed shearwater. 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 log₁₀ transformation and the anomaly calculation.

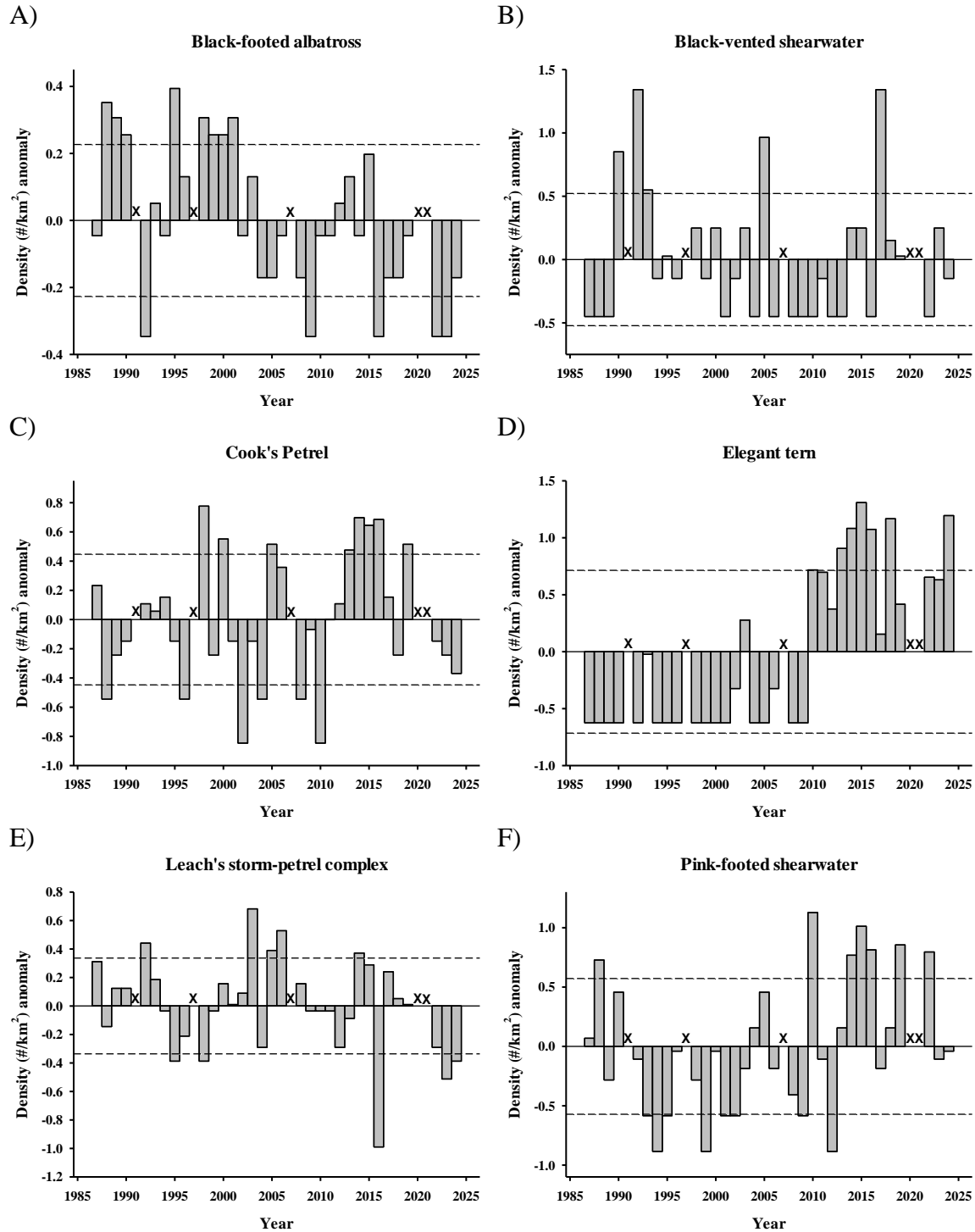


Figure 3. Log₁₀ density anomalies for species with cold-water affinities, core area only, 1987–2024. A) Bonaparte’s gull, B) common murre, C) rhinoceros auklet, D) Sabine’s gull, and E) sooty shearwater. The dashed lines indicate ± 1 s.d. of the long-term mean, and ‘X’ indicates years when no spring survey was conducted. A constant of 0.01 was added to each density prior to log₁₀ transformation and the anomaly calculation.

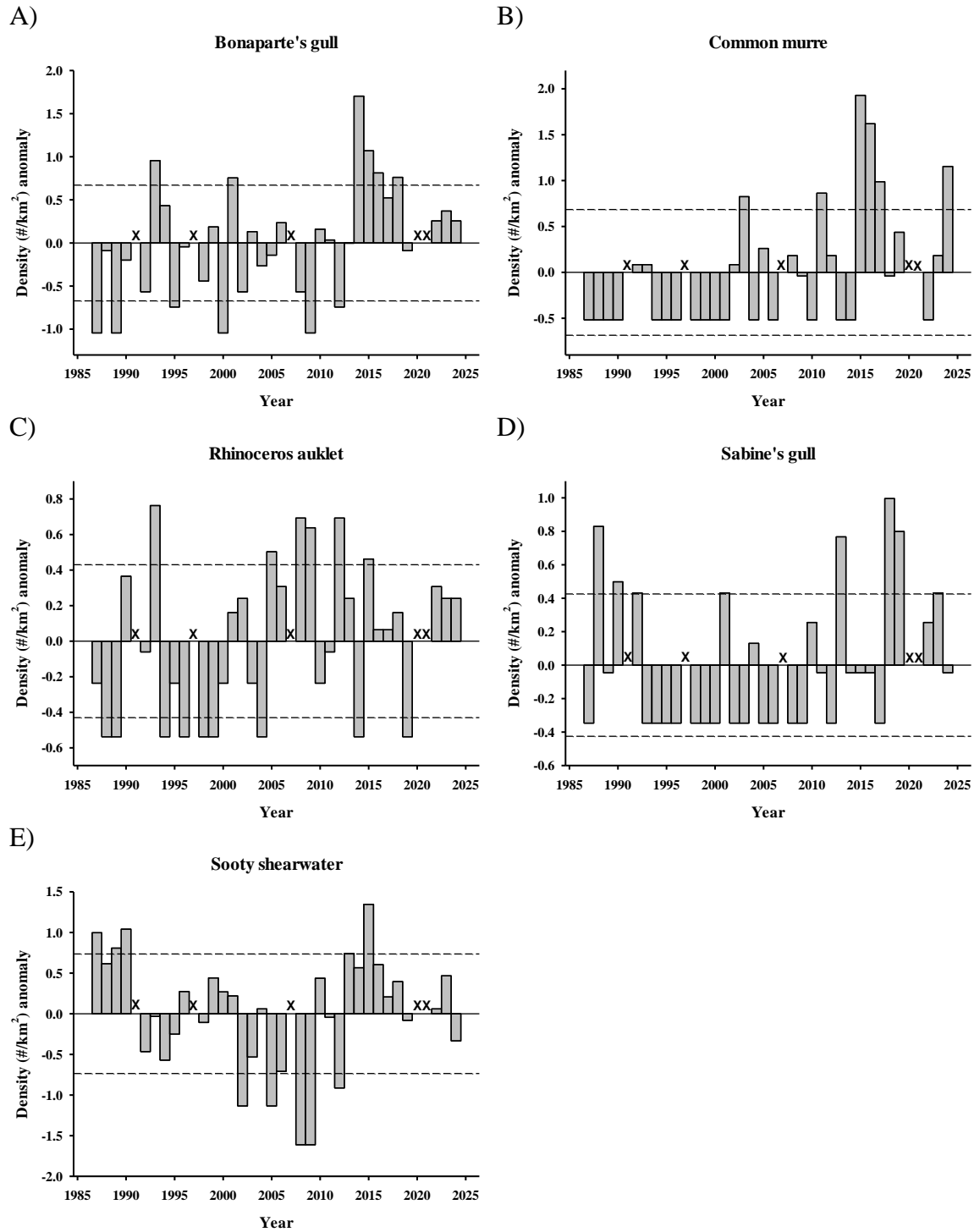


Figure 4. Log₁₀ density anomalies in the spring for all species in the core area only, 1987–2024. The dashed lines indicate ± 1 s.d. of the long-term mean, and ‘X’ indicates years when no spring survey was conducted. A constant of 0.01 was added prior to log₁₀ transformation and the anomaly calculation.

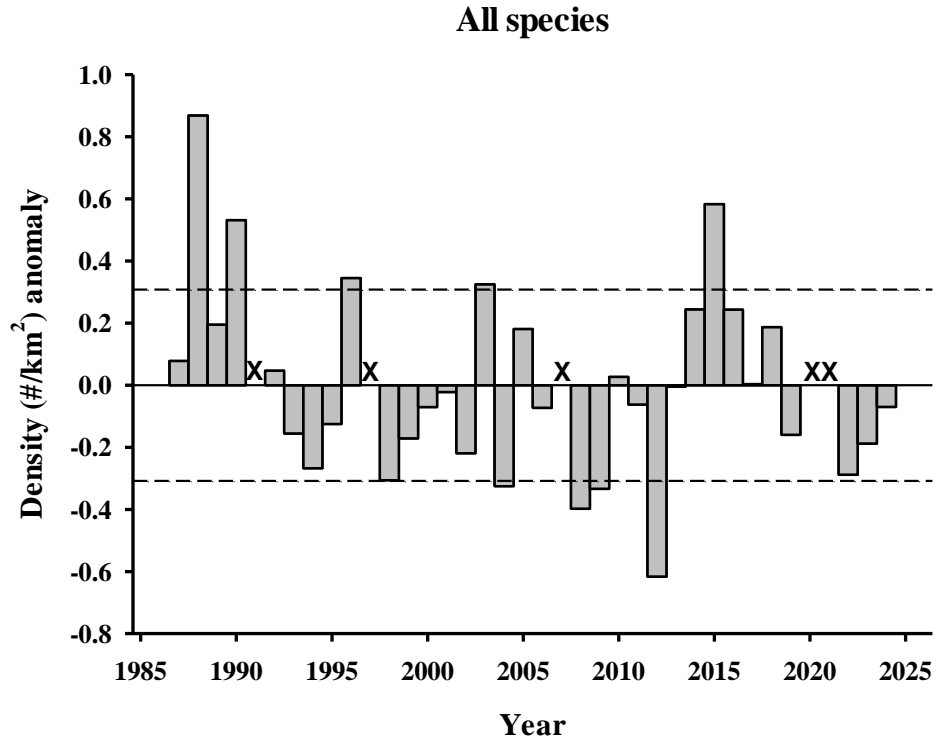


Figure 5. Sea surface temperature (SST; $^{\circ}\text{C}$) and wind averages (speed and direction) for the period 26 March to 19 April 2024 in the greater CalCOFI survey area. Wind direction is shown at NOAA/NDBC buoys (purple dots and orange star). White dots indicate CalCOFI sampling stations.

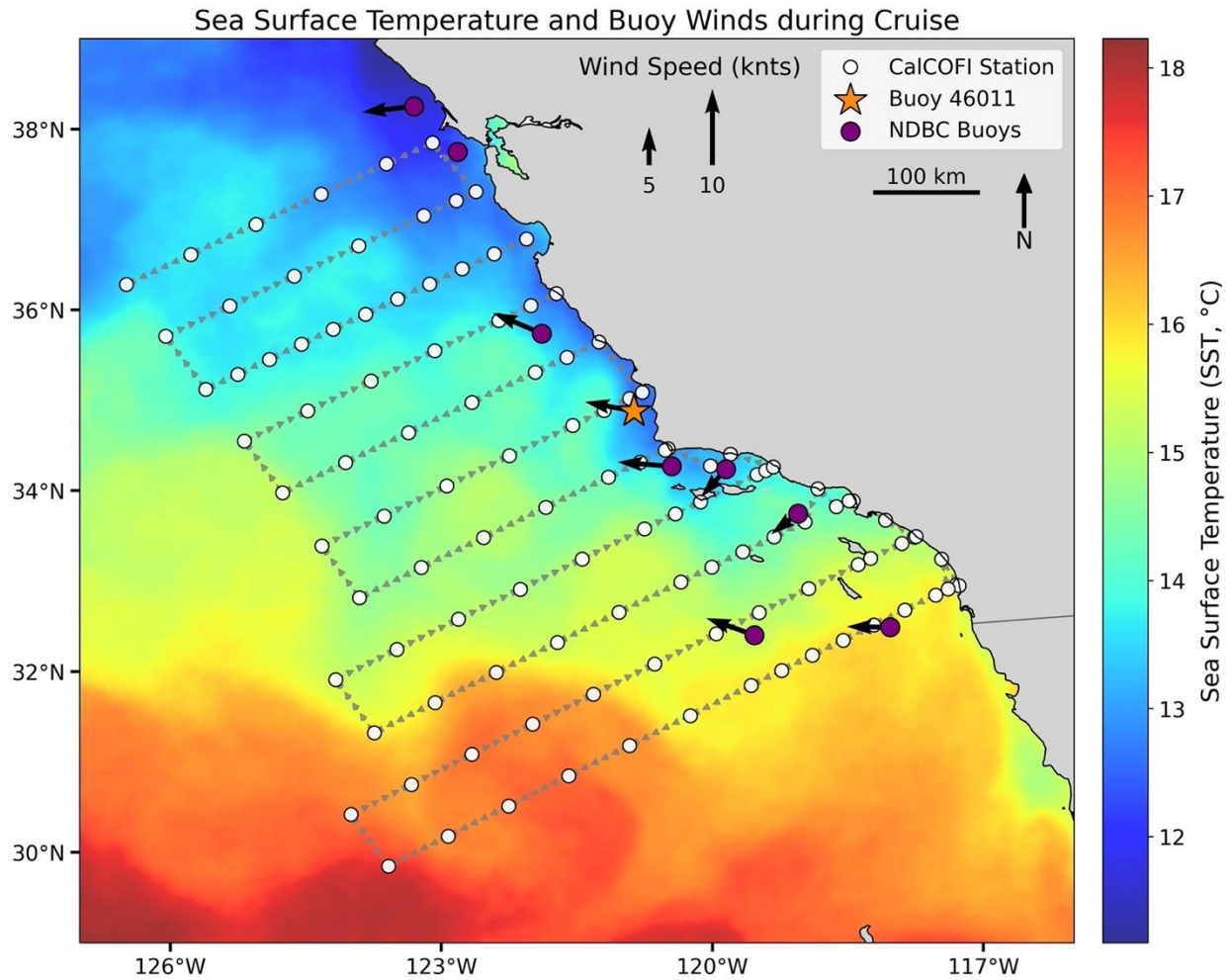


Figure 6. Sea surface temperature anomalies (SSTa; C°) averages for the period 26 March to 19 April 2024 in the greater CalCOFI survey area. Baseline period: 1991–2020. NOAA/NDBC buoys shown in Figure 5 are shown again here.

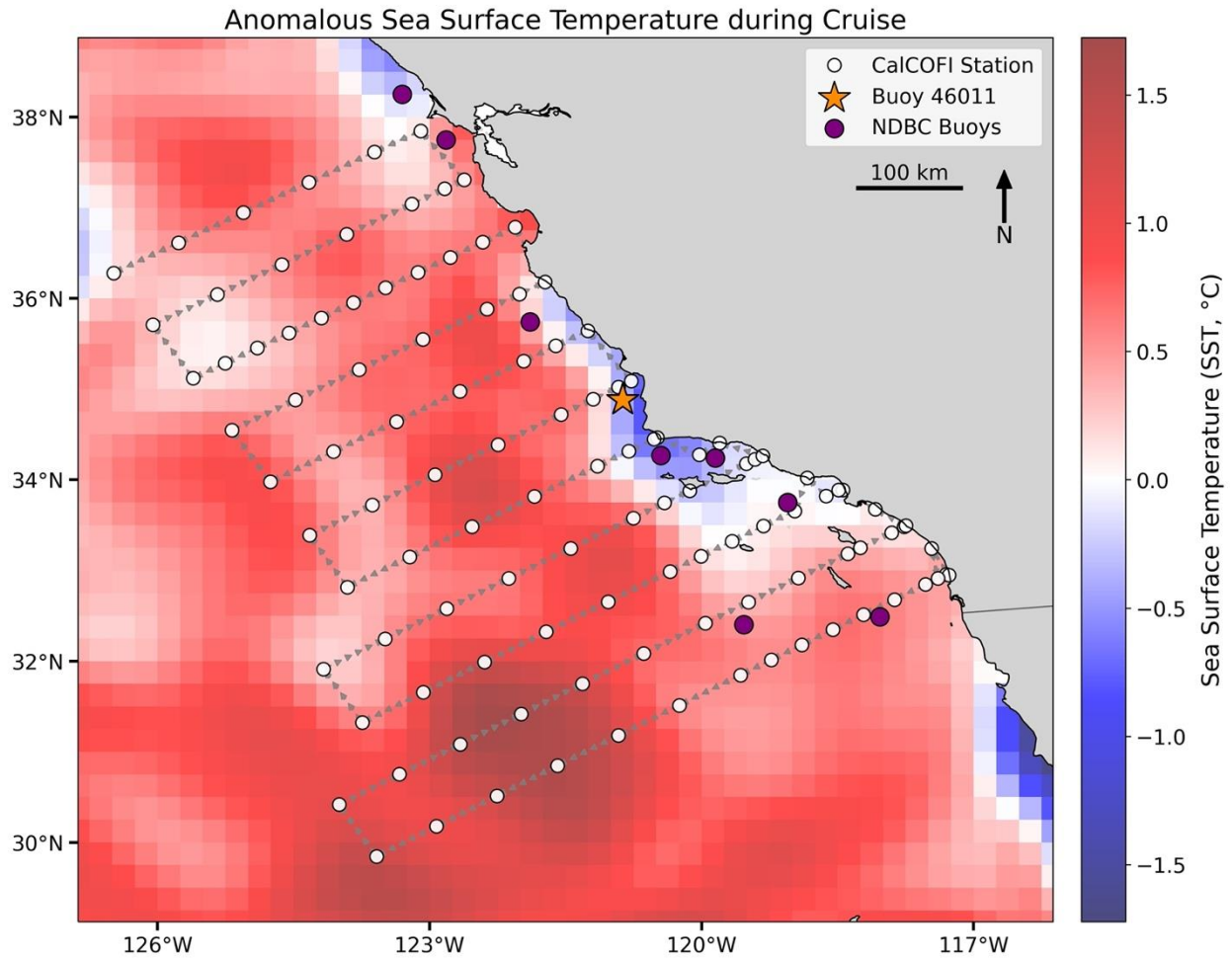
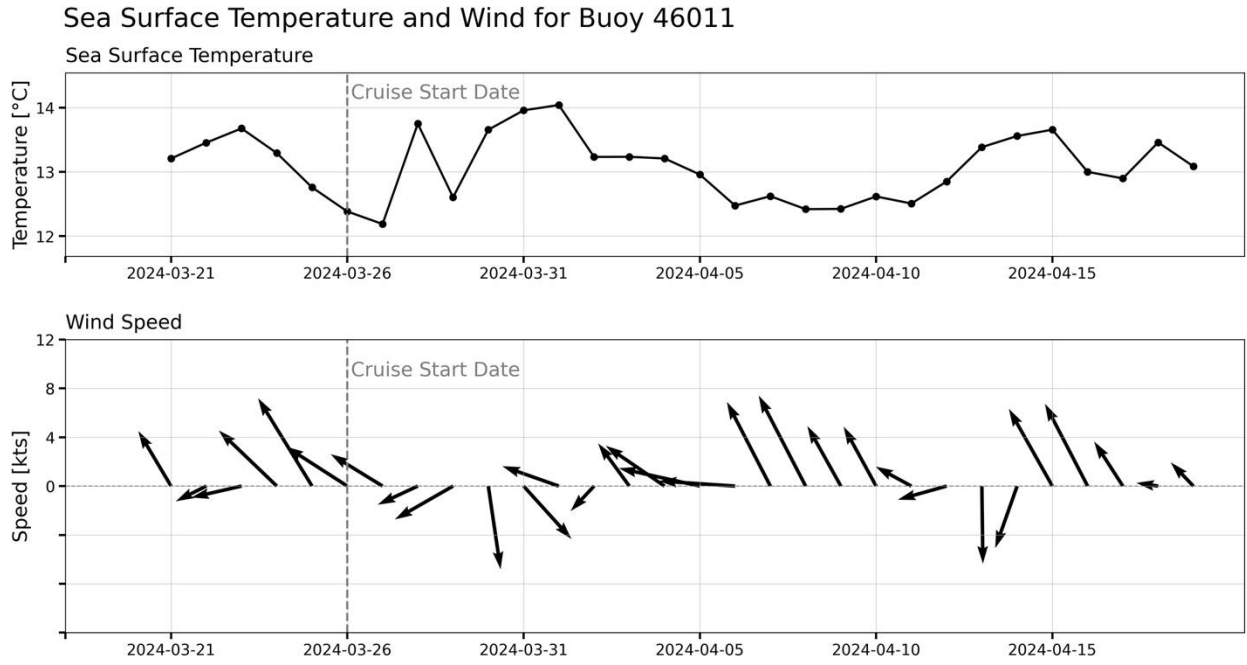


Figure 7. Daily SST (C°) and wind averages for the period 26 March to 19 April 2024 at NOAA/NDBC buoy 46011; location is marked in Figures 5 and 6 with an orange star. The beginning of the cruise is shown with a dashed vertical line. Bottom panel: arrow direction indicates wind direction (up = north), the y-axis indicates wind speed scale in knots.



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