POPULATION INDICES, TRENDS, AND DISTRIBUTION OF BREEDING WATERBIRDS ON THE ARCTIC COASTAL PLAIN, ALASKA, 2007-2024

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ABSTRACT

The Arctic Coastal Plain Aerial Breeding Population Survey (ACP Survey) provides data on the distribution and relative abundance of 33 bird species (including 29 waterbird species) that nest in northern Alaska. Among those reported are species of conservation concern, including threatened spectacled and Steller's eiders, yellow-billed loons, and snow geese. This report focuses on results from the 2018-2024 ACP surveys and presents population indices for all species from 2007- 2024. No surveys were conducted in 2020-2021 due to the COVID pandemic. For surveys flown in 2018, 2019, 2022-2024, the respective indicated total bird indices and their associated 95% confidence intervals (CI) for spectacled eiders were 4,745 (3,212 - 6,277), 3,738 (2,820 - 4,656), 2,335 (1,556 - 3,115), 2,284 (1,494 - 3,074), and 2,008 (1,138 - 2,878); and for Steller's eiders were 95 (0 - 300), 167 (14 - 320), 188 (0 - 468), 96 (0 - 276), 286 (0 - 577). Long-term (2007-2024) mean annual population indices and trends (and their associated 95% CIs) for these species and others of conservation concern, were as follows: spectacled eiders (indicated total birds) 5,012 (3,661 - 6,362), growth rate 0.93 (0.90 - 0.97); Steller's eiders (indicated total birds) 169 (0 - 466), growth rate 1.05 (0.75 - 1.44); yellow-billed loons (total birds) 2,120 (1,580 - 2,660), growth rate 1.00 (0.95 - 1.05); and snow geese (total birds) 41,814 (1,051 - 82,576), growth rate 1.12 (1.00 - 1.25). Our population indices do not account for incomplete detection or other sources of bias at this time, although the model we used to estimate growth rate removes average observer effects. Posterior probabilities for a long-term (2007–2024) growth rate < 1.00 were > 0.975 for scaup, spectacled eiders, king eiders, and jaeger species, indicating high confidence in long-term population declines for these species. By the same metrics, posterior probabilities for population increase were $\geq$ 0.90 for snow geese and sandhill cranes, indicating moderate confidence in long-term population increases for these species, while mallards and common ravens showed moderate confidence for decreasing trends (> 0.90 posterior probability of decrease). Growth rates for greater white-fronted geese and tundra swans indicated relatively stable populations (95% credible interval bounds for long-term growth rate were $\pm$ 3% of a long-term growth rate of 1.00), although the posterior probability of a decrease for tundra swans was 0.91, indicating moderate confidence in a slow decrease for that species. Confidence in directional trends for all other species was more limited (< 0.90 posterior probability for decrease or < 0.80 for increase).

Key Words

Aerial breeding pair survey, Alaska, Arctic Coastal Plain, population index, growth rate, species occurence, spectacled eider *Somateria fischeri*, snow goose *Anser caerulescens*, Steller's eider *Polysticta stelleri*, trend, waterfowl, waterbird, yellow-billed loon *Gavia adamsii*.

INTRODUCTION

The Arctic Coastal Plain (ACP) is a vast area of Arctic lowland tundra in far northern Alaska important for many species of breeding birds (Johnson et al. 2007; Bart et al. 2013; Amundson et al. 2019), especially waterbirds. Importantly, it is the only regularly used breeding area for the threatened population of Steller's eiders (*Polysticta stelleri*: USFWS 2002), and one of only three breeding areas for threatened spectacled eiders (*Somateria fischeri*: USFWS 1996). Additionally, the ACP hosts many other waterbird species of conservation concern, including red-throated (*Gavia stellata*) and yellow-billed loons (*G. adamsii*), snow geese (*Anser caerulescens*), Pacific black brant (*Branta bernicla nigricans*), common eiders (*S. mollissima*), black (*Melanitta americana*) and white-winged scoters (*Melanitta deglandi*), and long-tailed ducks (*Clangula hyemalis*).

Annual aerial surveys of waterbirds on the ACP have been conducted since 1986. Prior to 2007, two surveys with different timing and coverage (i.e., the Original ACP Survey, 1986–2006: Brackney and King 1993; Mallek, Platte, and Stehn 2007; and the North Slope Eider Survey, 1992–2006: Larned, Stehn, and Platte 2006) were used to monitor waterbirds on the ACP. In 2007, the two historical surveys were merged (Stehn, Larned, and Platte 2013), and the amalgamated survey, called the "Arctic Coastal Plain Aerial Breeding Population Survey", hereafter "ACP Survey" (Larned, Stehn, and Platte 2008, 2012; Stehn, Larned, and Platte 2013; Stehn 2014; Wilson, Larned, and Swaim 2018) has been flown annually since 2007 (with the exception of 2020 and 2021, due to the COVID pandemic). The survey provides distribution and abundance information for 33 species of birds, including loons, swans, geese, ducks, gulls, jaegers, terns, and selected landbird species breeding in northern Alaska. These results provide population status and distribution information to the Pacific Flyway Council, the Alaska Migratory Bird Co-Management Council, spectacled and Steller's eider Recovery Teams, U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey, Bureau of Land Management, North Slope Borough, various non-governmental organizations, local communities, consulting firms, and industry. This report focuses on the previously unreported 2018-2024 survey data and presents updated population information for all 33 bird species monitored from 2007-2024.

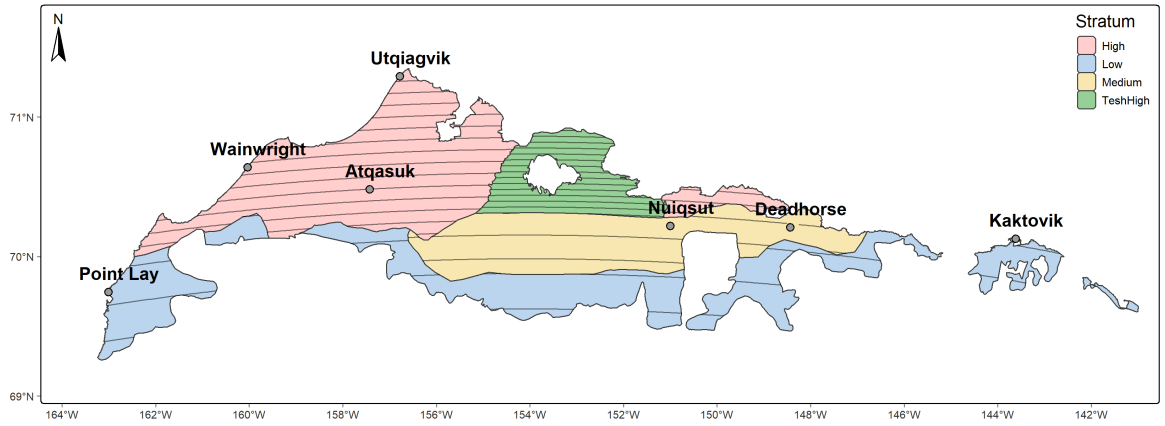

Figure 1: Study area and survey design for the Arctic Coastal Plain Aerial Breeding Population Survey (ACP Survey) in northern Alaska, illustrating the 2024 transects, strata, and village locations. The exact locations of survey transects vary slightly each year based on a four-year rotating panel within four physiographic and bird-density-based strata (high, medium, low, and Teshekpuk high).

METHODS

Survey Design

The ACP Survey study area encompasses 57,339 km^2, of tundra wetlands, extending from the Chukchi Sea coast in the west to the Canadian border in the east, and from the foothills of the Brooks Range to the Beaufort Sea. As flown since 2007, the ACP Survey is broken into four physiographic and bird-density-based strata, with a 4-year rotating panel of systematic strip-transects within each stratum (Figure 1). Herein, the within-strata sampling effort is proportional to bird densities, such that fewer transects are surveyed in strata where bird densities are lower. The four-year rotating panel design results in the panel (i.e., group) of transects being shifted by 25% of the inter-transect distance each year. The annual inter-transect distances for each of the four ACP Survey strata are 4.8 km (Teshekpuk High), 9.6 km (High), 19.2 km (Medium), and 28.8 km [Low; Larned, Stehn, and Platte (2012), Figure 1]. Given the 400 m transect

width, this results in average annual sampling fractions of ~7.3%, 3.7%, 1.8%, and 1.1%, in the respective strata. Thus, within a 4-year panel of transects the inter-transect distances for each of the four ACP Survey strata become 1.2 km (Teshekpuk High), 2.4 km (High), 4.8 km (Medium), and 7.2 km (Low), resulting in sampling fractions of ~29.1%, 14.7%, 7.2%, and 4.2%, in the respective strata over a four-year period. Total areas of each stratum are Teshekpuk High: 5,654 km^2, High: 20,351 km^2, Medium: 13,065 km^2, and Low: 18,266 km^2.

Survey Methods

The ACP Survey methodology is based on standard operating procedures for the North American Waterfowl Breeding Population and Habitat Survey (USFWS and CWS 1987), with both the left-front seat biologist-pilot and right-front seat observer recording all waterfowl, loons, gulls, jaegers, terns, eagles, owls, and ravens seen within a strip transect encompassing 200 m on either side of the flight path. To estimate the outer transect boundary, crews determine the required viewing angle trigonometrically and mark a reference point on the wing strut and side window for each observer, using a clinometer and marking tape/pens. Surveys are flown at an approximate ground speed of 161 km/hr (~87 kts; though actual ground speeds vary due to winds), and an altitude of 38 m (125 ft) above ground level (AGL), as referenced by a radar altimeter installed in the aircraft. Georeferenced observations made from both sides of the aircraft are voice-recorded into panel-mounted devices for later transcription using the custom software packages RECORD and TRANSCRIBE (2018-2022: Hodges 2015) and H2 and SCRIBE (2023-present: SWYM 2021). Since 2014, we used a Cessna 206 amphibious-equipped aircraft (Cessna Aircraft Company, Wichita, KS) and the same survey crew in all of the years for which we are presenting new data (2018-2019, 2022-2024; Table 1 and Table 2). The survey required 65, 52, 52, 47, and 47 flight-hours to complete, respectively, in 2018-2019 and 2022-2024, not including ferry time from Anchorage to and from the study area.

Table 1: Arctic Coastal Plain Aerial Breeding Population Survey (ACP Survey) dates and crews (2007-2024). The current ACP Survey combines the timing of the historical North Slope Eider Survey (1992-2006) with the geographic coverage of the Original ACP Survey (1986-2006), and has been flown since 2007. No surveys were flown in 2020 or 2021 due to the COVID pandemic. Aircraft used were either amphibious-equipped Cessna 206 (C206) or Kodiak 100.

	Dates of	**Pilot**	**Non-pilot**	
Year	**Data Collection**	**Left-front observer**	**Right-front observer**	**Aircraft**
2007	14-19 June	W. Larned	R. MacDonald	C206 Amphib
2008	8-16 June	W. Larned	R. MacDonald	C206 Amphib
2009	7-15 June	W. Larned	R. MacDonald	C206 Amphib
2010	11-22 June	W. Larned/K. Bollinger	W. Schock	C206 Amphib
2011	10-19 June	W. Larned	W. Schock	Kodiak Amphib
2012	12-18 June	H. Wilson/ W. Larned	H. Wilson/W. Larned	Kodiak Amphib
2013	10-17 June	H. Wilson	W. Larned	C206 Amphib
2014	10-20 June	H. Wilson	W. Larned	C206 Amphib
2015	8-14 June	H. Wilson	W. Larned	C206 Amphib
2016	6-13 June	H. Wilson	W. Larned	C206 Amphib
2017	11-19 June	H. Wilson	W. Larned	C206 Amphib
2018	15-25 June	H. Wilson	D. Safine	C206 Amphib
2019	8 -16 June	H. Wilson	D. Safine	C206 Amphib
2020	No Survey Flown	-	-	-
2021	No Survey Flown	-	-	-
2022	14-21 June	H. Wilson	D. Safine	C206 Amphib
2023	11-18 June	H. Wilson	D. Safine	C206 Amphib
2024	14-21 June	H. Wilson	D. Safine	C206 Amphib

Survey Timing and Weather Conditions

Timing of survey initiation is intended to coincide with the egg laying/early incubation period of nesting geese and eiders on the ACP, and the peak presence of male ducks and pairs of other waterfowl species. This is a period when nesting habitat is just becoming available (i.e., ice-free water is visible in most shallow vegetated wetlands, and tundra vegetation is mostly snow-free around pond margins), typically within the first three weeks of June. According to Troy

(1997), median nest initiation dates for spectacled eiders at Prudhoe Bay averaged 15 June from 1982 to 1996, with males departing within 3–5 days of median initiation. More recent data from Utqiagvik, estimated average spectacled eider nest initiation to be 14 June (Safine 2013), consistent with indicated average (5-year; 2017-2019, 2021-2022) nest initiation for cackling geese on the Canning River Delta (14 June; C. Latty, personal communication, Feb. 11, 2025). Within the first two weeks of June each year (Table 1), we refined our survey start dates based on close monitoring of weather and temperature data, examining snow and ice-cover changes via satellite (NASA Worldview) and web-camera imagery (https://weathercams.faa.gov//), and by receiving updates on current landscape conditions from biologists and other local residents on the ACP. From 2018–2024, weather conditions varied considerably within and among survey years. Reduced visibility and ceilings due to coastal fog were the most consistent weather impediments to surveying in all years of the survey. Fog was particularly troublesome along the northern coastal fringe of the study area, where on-shore winds (blowing over the ice), small temperature-dew point spreads, and daily temperature cycles often created instantaneous, low-visibility conditions.

Population Indices

We calculated population indices to be consistent with their use in other USFWS surveys. Duck indices followed the guidance of USFWS and CWS (1987), and goose, swan, and crane indices followed Eldridge (2003). Pairs were defined as the total number of male-female pairs (or two monomorphic birds [e.g., geese] in close association), not the total number of birds in pairs (USFWS and CWS 1987). Flocked drakes were defined as the total number of males observed with one or more other males and no female present (USFWS and CWS 1987), and were only recorded for ducks. Flocked drakes in groups of less than 5 birds were doubled (except for scaup; see below), and flocked drakes in groups of 5 or more were treated as a flock and not doubled (USFWS and CWS 1987). Flocks were defined as a closely associated single-sex or mixed-sex grouping of 5 or more birds (or 2 or more birds of different species) that could not be separated into singles and pairs. For scaup, single drakes and flocked drakes in groups of less than 5 birds were not doubled as they were for other ducks. This is because sex ratios in scaup lean heavily towards males, such that not all males can be assumed to have a female mate (USFWS and CWS 1987). From 2007 to 2023, our breeding birds index for scaup did not include flocked drakes in groups of less than 5 birds, leading to an average bias in the breeding birds index for scaup of -10%. Starting in 2024, the breeding birds index for scaup began to include flocked drakes. Formulas for the calculation of the four population indices presented in this report are shown below.

For dimorphic species (e.g., ducks [except scaup]) and some monomorphic species (cranes and dark geese [e.g., greater white-fronted geese, cackling/Canada geese, and brant]):

$$\textit{Indicated Breeding Birds} = 2(\textit{singles} + \textit{pairs} + \textit{flocked drakes in groups of} < 5 \textit{ birds})$$

$$\textit{Indicated Total Birds} = 2(\textit{singles} + \textit{pairs} + \textit{flocked drakes in groups of} < 5 \textit{ birds}) + \textit{birds in flocks}$$

For the remainder of the monomorphic species (e.g., swans, snow geese, grebes, loons, terns, gulls, jaegers, owls, eagles, ravens) and scaup species:

$$\textit{Breeding Birds} = \textit{singles} + 2(\textit{pairs}) + \textit{flocked drakes in groups of} < 5 \textit{ birds}$$

$$\textit{Total Birds} = \textit{singles} + 2(\textit{pairs}) + \textit{flocked drakes in groups of} < 5 \textit{ birds} + \textit{birds in flocks}$$

The Ratio Estimator

Population totals for each index were calculated using a ratio estimator (Cochran 1977) with transects as the sample units. The classical ratio estimator (Cochran 1977) is a straightforward approach that can be used to estimate the population total of observed birds in a survey area given a systematic or random sampling design with large sample size (i.e., number of transects). The ratio estimator is especially good when the response (i.e., number of birds on a transect) is linearly related to the length or area of the transect. We employed a stratified strip-transect design for the majority of our surveys of breeding waterfowl. Study areas are separated into spatial strata based on physiographic features and historical bird densities. Strata were sampled by low-level flights along a series of strip transects, with one or two observers searching 200 meters out from the transect center. Observations and sampled areas are then summed across transects within each stratum to produce strata-specific density estimates. These densities are then multiplied by associated strata areas to produce stratum-specific population indices that are summed to produce the

overall population indices,

$$E[\hat{Y}] = \sum_{i}^{S} \frac{\bar{y}_i}{\bar{a}_i} A_i = \sum_{i}^{S} \hat{D}_i A_i$$

where y_i are observations and a_i are sampled areas in strata i, and

$$A_i = \sum_{j}^{M_i} a_{ij}$$

with estimated variance from Williams et al. (2002), where standard error (SE) is calculated based on inter-transect variance,

$$Var(\hat{Y}) = \sum_{i}^{S} M_i^2 \frac{(1 - m_i/M_i)}{m_i} (s_{iy}^2 + \hat{D^2}_i s_{ia}^2 - 2\hat{D}_i s_{iay}),$$

where m_i and M_i are the number of sampled and total transects in strata i, respectively, and there are S total strata;

$$S_{ix}^2 = \sum_{j}^{m_i} (x_{ij} - \bar{x})/(m_i - 1),$$

and

$$S_{ixy}^2 = \sum_{j}^{m_i} (x_{ij} - \bar{x})(y_{ij} - \bar{y})/(m_i - 1).$$

The equations above are observer-specific (i.e., calculated for each observer independently). However, the estimates presented in this report are the arithmetic mean of observer-specific estimates (n=2, in most years). Design transects (Figure 1) were used to calculate survey effort, but flight lines sometimes deviated slightly from the these due to weather avoidance or other factors. Data manuplulation was completed using the R (R Core Team 2024) package `AKaerial` (Frost 2024).

Population indices presented here do not account for incomplete detection, though there are efforts to incorporate detection data into annual population estimates for some species (Wilson, Stehn, and Fischer 2017; Osnas 2024b). Summary statistics were calculated for the indicated total bird (or total bird) index for each bird species, including the long-term (2007- 2024) and most recent 3-year averages and their standard errors (Table 2). Indicated breeding bird (or breeding bird) indices and indicated total bird (or total bird) indices for each bird species are presented in the Appendices (Table 3 - Table 35 and Figure 4 - Figure 68). Throughout, we report point estimates $\pm$ (1.96 x SE) as a 95% confidence interval, except in the simulations for trends (see next section).

Index Trends

Trajectories in population indices were estimated using generalized additive models (GAM, Wood 2017) in the R package `mgcv` (Wood 2021) fit to observer-specific index estimates. The GAM model used a scaled-t likelihood, a continuous smooth term for year, and a random effect for observer in the linear predictor. The observer effect allowed us to remove observer-specific effects from any estimated average trajectory, and the scaled-t likelihood allowed for extra residual variance from the trend line over a normal likelihood that might be due to additional year-specific variance from the trend line. To account for uncertainty in the index estimate, we used a parametric bootstrap of the estimated index as the modeled response in the GAM. Thus, for each year, a response was sampled from a normal distribution (with the mean and standard deviation of the point estimate), truncated to a small value (1e-10) for samples ≤ 0, and log-transformed. Then a GAM was fit, and a sample of the parameters was obtained from a multivariate normal distribution using the estimated parameter vector and covariance matrix. Annual predictions over the full time series were made from this parameter sample after removing the effect of observer, and the results were saved. This procedure was repeated 300 times. As such, this procedure is an empricial Bayesian method to approximate the posterior distribution of the trajectory (Miller 2025). For rarer species, some of which were not observed in all years (e.g., red-necked grebes and Steller's eiders), we excluded years when no birds were observed. We did this because observed zeros in these design-based estimates are more likely due to non-detection or random sampling, rather than complete absence of the species in the survey area, and model-fit to data that included zeros did not produce stable estimates. However, we acknowledge that this may have resulted in some over-smoothing and bias of estimated trends for species with zero-count years. For improved methods, that better account for zero observations in rare species see Osnas (2024b).

We summarized the simulated yearly GAM predictions (i.e., the posterior distribution of trajectories) by calculating the mean and standard deviation for each year. An example of simulated results and observer-specific estimates for one species (Pacific loon) is shown in Figure 2. For plots and tables presented in the Results and Appendices, we do not report the observer-specific index estimates or individual samples of the smooths, in an effort to reduce clutter. Instead, we show only the average index between observers in any year, the mean posterior trajectory, and $\pm$ 2 standard errors from this mean.

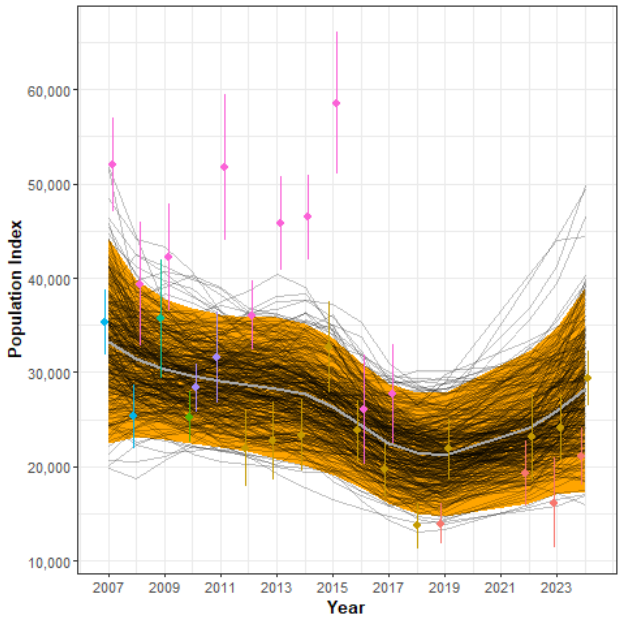

Figure 2: An example of the modeled index estimates and trend results for Pacific loon, accounting for observer effects. Colored points and bars are observer-specific index estimates, which were sampled 300 times and used as the response in a generalized additive model. Individual modeled predictions for each sample are shown by the thin gray lines. These make up the posterior distribution of modeled trajectories and are summarized by the orange band (approximate 95% credible interval) and the thick gray line (posterior mean). End points of the modeled predictions (thin gray lines) are used to calculate the posterior distribution of the long-term growth rate.

We estimated the long-term average growth rate from year a to b for each simulated replicate as

$$T_{b-a} = (\hat{N}_b / \hat{N}_a)^{1/(b-a)},$$

where $\hat{N}_t$ is the predicted index value at year t from the bootstrap replicate GAM model, $t = a$ is the first year of a non-zero estimate, and $t = b$ is the last year. Thus, the growth rate was calculated as the geometric mean annual change in the model-predicted index. We summarized growth rate by the mean and 95% credible interval across the sampled replicates. We also calculated the posterior probability of a negative growth rate by summarizing the proportion of posterior samples that were < 1 (Pr[Trend < 1], Table 2). We only calculated growth rate for total or indicated total bird indices shown in Table 2. Code is available in the file `plot_trends_design.R` at (Osnas 2024a).

RESULTS

Survey Timing and Weather Conditions

Dates of data collection for 2018-2019, and 2022-24 were: 15-25, 8-16, 14-21, 11-18, and 14-21 June, respectively (Table 1). Survey timing was the latest on record for the survey in 2018 (15-25 June; Table 1). The first day of data collection on the ACP in 2018 was 5 days later than the long-term (2007-2024) average start date of 10 June. In 2018, in particular, sustained cold temperatures, strong east winds, and significant snow and ice covered much of the northern ACP landscape well into June. While 2018, 2022, and 2024 were on the later end of the range of start dates (Table 1), 2019 was a relatively early year on the ACP. Breakup chronology on the ACP varies greatly annually, but in general, we have observed later breakups in the years we have surveyed since 2017.

Table 2: The most recent 3-year (2022-2024) and long-term (2007-2024) average population indices and associated standard errors (SE), as well as long-term annual growth rates (long-term trend), associated 95% credible intervals (CI), and posterior probability that a trend is decreasing (Pr[Trend < 1]) for bird species on the Arctic Coastal Plain Aerial Breeding Population Survey in Alaska. Index formulas used are species-specific, with indicated total birds (ITB) used for dimorphic species, dark geese, and sandhill cranes, and total birds (TB) used for the remaining monomorphic species, other than dark geese, sandhill cranes, and scaup. See the Methods section for detailed index definitions and trend calculations. Estimates are not corrected for incomplete detection, but trends do account for observer effects.

		3-Year		Long-term		Long-term	
Species	**Index**	**Average**	**SE**	**Average**	**SE**	**Trend (CI)**	**Pr(Trend < 1)**
Snow goose	TB	72,025	24,401	41,814	20,797	1.12 (1.00 - 1.25)	0.03
Greater white-fronted goose	ITB	198,988	12,014	232,847	13,604	1.00 (0.97 - 1.02)	0.61
Brant	ITB	15,739	4,815	14,516	3,693	1.02 (0.95 - 1.08)	0.30
Cackling/Canada goose	ITB	14,480	2,133	13,169	2,457	1.01 (0.95 - 1.07)	0.27
Tundra swan	TB	12,881	1,377	14,833	1,388	0.99 (0.97 - 1.01)	0.91
Northern shoveler	ITB	145	110	437	189	0.95 (0.74 - 1.18)	0.69
American wigeon	ITB	513	281	724	308	1.03 (0.89 - 1.16)	0.36
Mallard	ITB	319	109	566	258	0.90 (0.75 - 1.03)	0.93
Northern pintail	ITB	42,339	4,284	60,631	6,836	0.99 (0.95 - 1.03)	0.73
American green-winged teal	ITB	282	112	512	164	0.96 (0.86 - 1.06)	0.84
Scaup species	TB	12,295	1,258	17,557	2,366	0.95 (0.92 - 0.98)	1.00
Steller's eider	ITB	191	130	169	152	1.05 (0.75 - 1.44)	0.43
Spectacled eider	ITB	2,210	415	5,012	689	0.93 (0.90 - 0.97)	1.00
King eider	ITB	10,784	988	17,518	1,809	0.96 (0.94 - 0.99)	1.00
Common eider	ITB	699	403	946	827	1.02 (0.86 - 1.21)	0.41
Surf scoter	ITB	699	391	262	218	1.11 (0.68 - 1.62)	0.28
White-winged scoter	ITB	5,939	867	9,820	3,138	1.03 (0.96 - 1.12)	0.24
Black scoter	ITB	180	126	361	219	0.99 (0.69 - 1.45)	0.59
Long-tailed duck	ITB	32,277	1,994	43,306	2,788	0.99 (0.96 - 1.02)	0.74
Red-breasted merganser	ITB	1,442	308	1,617	311	1.01 (0.94 - 1.07)	0.43
Red-necked grebe	TB	61	60	65	56	0.96 (0.63 - 1.38)	0.62
Sandhill crane	ITB	709	194	601	224	1.06 (0.98 - 1.17)	0.10
Jaeger species	TB	5,833	484	8,174	602	0.96 (0.94 - 0.98)	1.00
Sabine's gull	TB	12,322	1,504	13,175	1,483	1.01 (0.98 - 1.04)	0.29
Glaucous gull	TB	17,802	4,445	24,108	6,549	0.99 (0.96 - 1.02)	0.78
Arctic tern	TB	14,403	1,393	19,395	1,799	0.98 (0.95 - 1.01)	0.89
Red-throated loon	TB	3,306	396	2,625	378	1.01 (0.97 - 1.05)	0.34
Pacific loon	TB	22,181	1,337	29,619	1,595	0.99 (0.96 - 1.01)	0.81
Yellow-billed loon	TB	1,682	221	2,121	276	1.00 (0.95 - 1.05)	0.51
Golden eagle	TB	246	80	262	77	1.01 (0.92 - 1.10)	0.43
Short-eared owl	TB	492	89	474	105	1.05 (0.94 - 1.19)	0.22
Snowy owl	TB	1,140	311	1,174	330	0.99 (0.88 - 1.10)	0.58
Common raven	TB	99	48	274	110	0.93 (0.83 - 1.03)	0.93

Population Indices

We summarize the most recent 3-year average (2022-2024) and long-term average (2007-2024) population indices, as well as long-term (2007-2024) posterior mean trajectories (trends) and associated 95% credible intervals (CI), as well as posterior probabilities that trends are decreasing (Pr[Trend < 1]) for 33 bird species observed on the ACP Survey (Table 2). Herein, we follow the taxonomic ordering of Chesser et al. (2024). For each species, we also present individual annual population indices (2007-2024) and trajectories in graphical and tabular formats, and maps of individual species-observations for 2024 (Appendices: Table 3 - Table 35 and Figure 4 - Figure 68). Though our maps provide accurate observation locations for each species, we caution that our location data should not be

interpreted as densities, due to differences in sampling effort across strata boundaries. Historical density models have been published for our previous data (Amundson et al. 2019), but more current density-modeling efforts (see Osnas 2024b) for all species in this report have not yet been completed.

DISCUSSION

This report describes trends in relative abundance for all common waterbirds (excluding shorebirds; due to their small size and inconsistent data collection), owls, eagles, and ravens on the ACP of Alaska, collected by USFWS from 2007-2024; including 2018–2024 survey data not previously reported. Upper 95% credible intervals for long-term (2007–2024) growth rates of scaup, spectacled eiders, king eiders, and jaeger species were all < 1.00 and the posterior probability that the trend was decreasing was > 0.975, indicating high confidence in population decreases for those species. Other species showed less evidence (lower posterior probability) for a population decrease (Table 2). With less, but still relatively high confidence, tundra swan (0.91), mallard (0.93), American green-winged teal (0.84), Arctic tern (0.89), Pacific loon (0.81), and common raven (0.93) all showed some evidence for a decreasing trend (Table 2). Snow geese showed a high probability (> 0.975) of a population increase, with a large magnitude (up to 25% per year). Greater white-fronted geese were relatively stable, with a mean growth rate centered on 1.0 and a 95% credible interval bound to less than a 3% increase or decrease. Growth rate posterior estimates for northern pintail, long-tailed duck, Sabine's gull, glaucous gull, and yellow-billed loon showed no strong evidence for a long-term directional trend, but were instead bound to within 5% annual changes from 1.00 and showed large year-specific variation or increasing and decreasing trends over shorter periods. Posterior estimates for other species showed less evidence for the sign or magnitude of long-term population change (Table 2).

Though observer bias is a factor in all aerial surveys, the experience-level and stability of the ACP Survey crew, particularly the left-seat pilot-observers, has been remarkably high. From 2007–2024, there were only two pilot-observers who collected left-seat data (Larned [2007-2011] and Wilson [2012-2024]) and viewed together, seats occupied by Larned and Wilson represented one third of all data collected over the duration of the survey (2007-2024; Table 1). Given this stability in observer-personnel, the estimated trends will be unbiased if there is little variation in detection or other observation processes within observers across years. We did, however, use a model to statistically remove average observer effects from the estimated average trajectory. This represents an improvement over past long-term trend estimates, and lacking any trend in detection or other observation biases, the trends reported here are the best currently available for this area without directly estimating these observer biases. Nevertheless, detection and availability biases are still largely unaccounted for, affecting our population indices. Thus, these estimate are not measures of absolute abundance. Though we do not provide detection-adjusted population estimates for 2007-2024, we did initiate a study examining observer detection of eiders and other waterbirds on the ACP in 2015 (Wilson, Stehn, and Fischer 2017) and hope to incorporate detection and observer-adjusted estimates into future reports using methods similar to Osnas (2024b).

The trajectories estimated here represent continuous smooth functions after removing average observer effects. We did not fit other models that allowed for more complex or discontinuous trends, such as year-specific random effects or spatially explicit predictions (e.g. Smith and Edwards 2021; Osnas 2024b). Because many species do show large year-specific deviations from an average trend, a model with such effects is likely a better description for these species. Such models are not well-estimated when fit to the design-based estimates used here. The model we have used, however, can be viewed as a flexible way to estimate the average trajectory through time, smoothing over year-specific variations. Compared to a simple log-linear regression on point estimates, the current approach provides for more flexible functional forms of the trajectory, allowing for the identification of cycles or periods of change. One should keep these points in mind when interpreting results, as for many species, the year-specific variations are much larger than the average change over time (e.g., northern pintail) or show cyclical patterns over a shorter time (e.g., long-tailed duck, yellow-billed loon).

Trajectories for rare species (those with observed zero estimates) should be interpreted with care. We attempted to fit our model by including zero estimates (after adding a small number and log transforming) but the GAM often failed to find stable estimates, so we used only positive estimates. This will have two important consequences. First, trajectories may be biased if there is a trend in the frequency of zero observations in the time series. Second, the GAM will tend to produce smoother trajectories than if the zeros were included. For example, the Steller's eider trajectory is essential a flat line (Figure 26); whereas Osnas (2024b) found clear cyclical patterns in the trajectory when a different GAM model was fit to smaller-scale, spatially-explicit counts that included zero-counts. Interestingly, Amundson et al. (2019) also excluded zero-counts in a spatially-explicit GAM, and found a flat trajectory for Steller's eider over a much longer time period; suggesting that the smooth GAM is due to a reduction in data when most observations are excluded. We expect similar patterns for other rare species. However, for more common species that do not include

zero estimates, we believe the current model should approximate temporal trajectories in relative abundance. In the future, we also hope to fit a spatial model to the full set of species.

Although the long-standing, continental-scale aerial Waterfowl Breeding Population and Habitat Survey (WBPHS) samples most of Alaska's primary waterfowl production areas, it has never included the rich wetlands of the Arctic Coastal Plain of Alaska or the high-Arctic of Canada in its annual efforts. Further, while several targeted monitoring programs for specific species or limited areas of the ACP have been conducted; to our knowledge, the ACP Survey represents the most comprehensive aerial survey of Arctic-breeding waterbirds in existence. The analysis and implementation of a multi-species, aerial monitoring program such as the ACP Survey is challenging due to the inherent variability of the natural ecosystem, the varied natural histories of 30+ species, and the logistical difficulties of conducting aerial surveys in the Arctic. Moreover, it is difficult to achieve adequate within-year sampling of such a large spatial area within a short annual phenological window. Surveys of this type are further complicated by several waterfowl species that exist in extremely low densities and/or breed irregularly (such as Steller's eiders), making precise estimates and trends difficult to achieve (though see Osnas 2024b). Collection of such a long-term data set has been made possible by integrating improvements in sample design along the way. The sample design used in this survey was originally developed in 1986 to target breeding ducks (Original ACP Survey 1986-2006: Mallek, Platte, and Stehn 2007), and later augmented to better include coastal areas and earlier-nesting species, such as eiders (North Slope Eider Survey 1992–2006: Larned, Stehn, and Platte 2008). The current redesigned survey (2007–present: Stehn, Larned, and Platte 2013; Wilson, Larned, and Swaim 2018) amalgamated these two designs and provides good temporal, spatial, and inferential compromise. However, the changing distributions and abundances of many waterfowl species, as well as the rapid and wide-spread landscape changes in the Arctic, may warrant reevaluation of the current stratification and overall survey design. Nonetheless, this survey represents one of few broad-scale, long-term, systematic monitoring efforts for waterbirds in the Arctic of North America, and perhaps, the world.

Supplemental Material

Species-specific population indices, trends, and spatial distributions of observations can be found in the tables and figures of the Appendices. Original data for the ACP Survey can be found at Science Base - Alaska Arctic Coastal Plain Breeding Waterbird Aerial Survey 2007-Present https://doi.org/10.7944/f6jd-2985 and point-estimates (and documentation of their calculation) were sourced from the R package AKaerial at https://github.com/USFWS/AKaerial. R Quarto code used to produce this report, the report itself, and associated tabular data, can be found at https://doi.org/10.7944/dqf4-2z27.

Suggested Citation

Wilson, H.M., Safine, D.E., Frost, C.J., and E.E. Osnas. 2025. Population indices, trends, and distribution of breeding waterbird on the Arctic Coastal Plain, Alaska, 2007-2024. Anchorage, Alaska: U.S. Fish and Wildlife Service, Migratory Bird Management. https://doi.org/10.7944/dqf4-2z27

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Figure 3: Arctic Coastal Plain Aerial Breeding Population Survey Crew 2018-2024: David Safine (right-front seat observer) and Heather Wilson (left-front seat observer/pilot)

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APPENDICES

Snow Goose

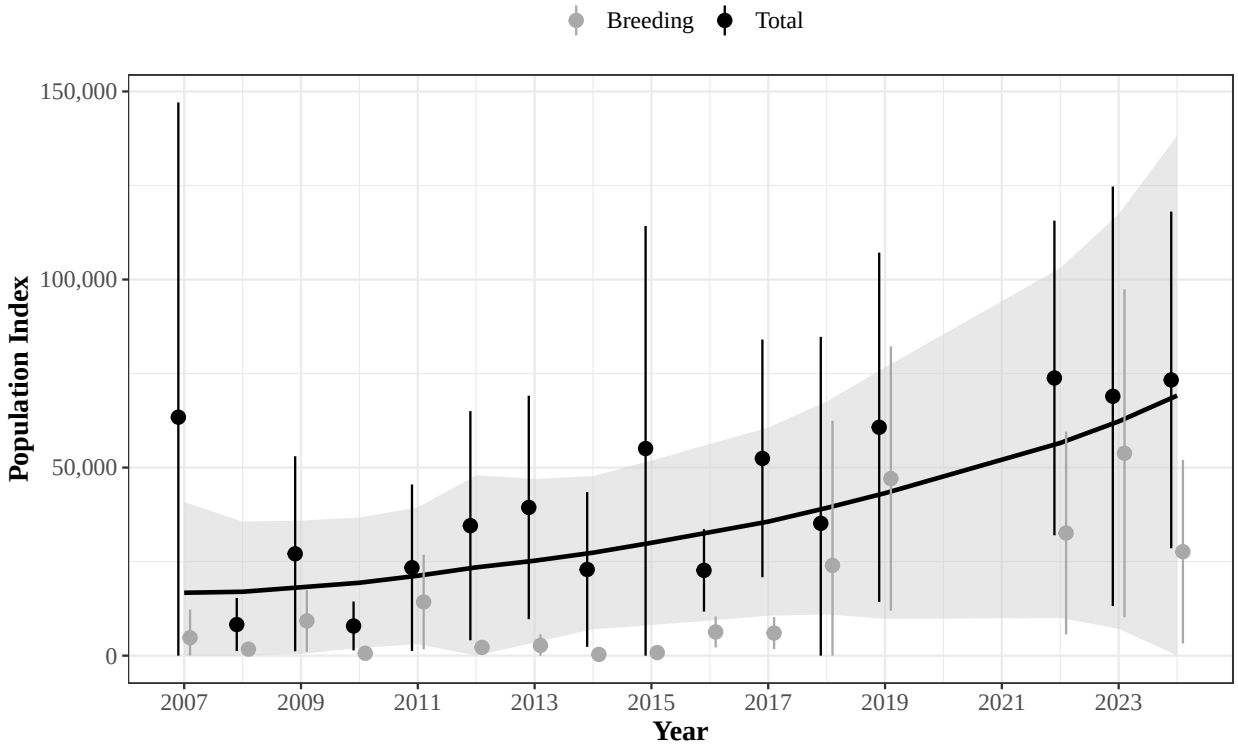

Figure 4: Snow goose indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Snow Goose

Table 3: Snow goose indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	4,777	3,791	63,398	42,695
2008	1,720	913	8,272	3,603
2009	9,231	4,200	27,078	13,228
2010	641	157	7,888	3,320
2011	14,272	6,417	23,388	11,291
2012	2,195	700	34,553	15,542
2013	2,712	1,492	39,402	15,159
2014	328	137	22,911	10,498
2015	814	231	55,061	30,188
2016	6,299	2,103	22,675	5,586
2017	6,012	2,160	52,434	16,123
2018	23,989	19,634	35,174	25,293
2019	47,090	17,923	60,717	23,686
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	32,589	13,753	73,822	21,341
2023	53,799	22,238	68,955	28,451
2024	27,630	12,452	73,299	22,834

Snow Goose

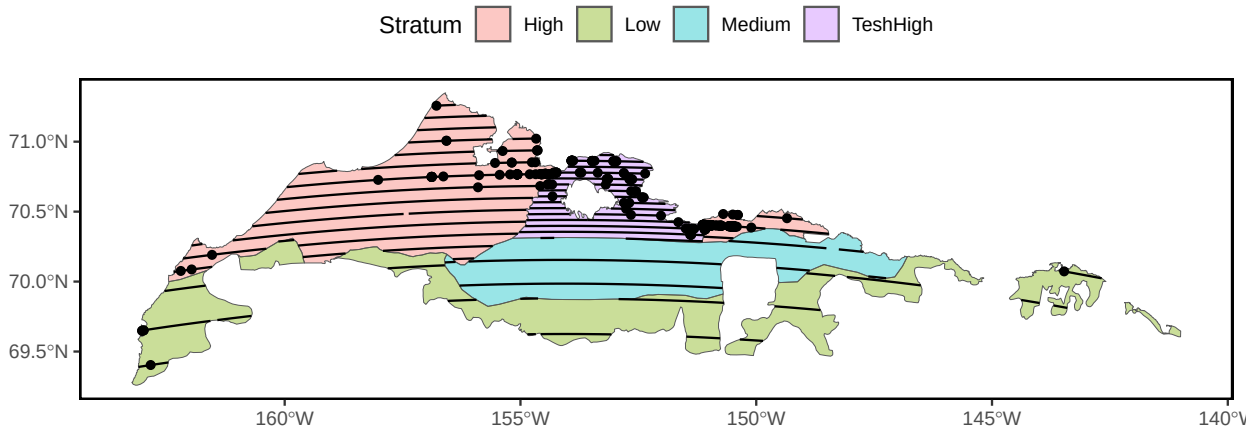

Figure 5: Observations of snow geese along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Greater White-fronted Goose

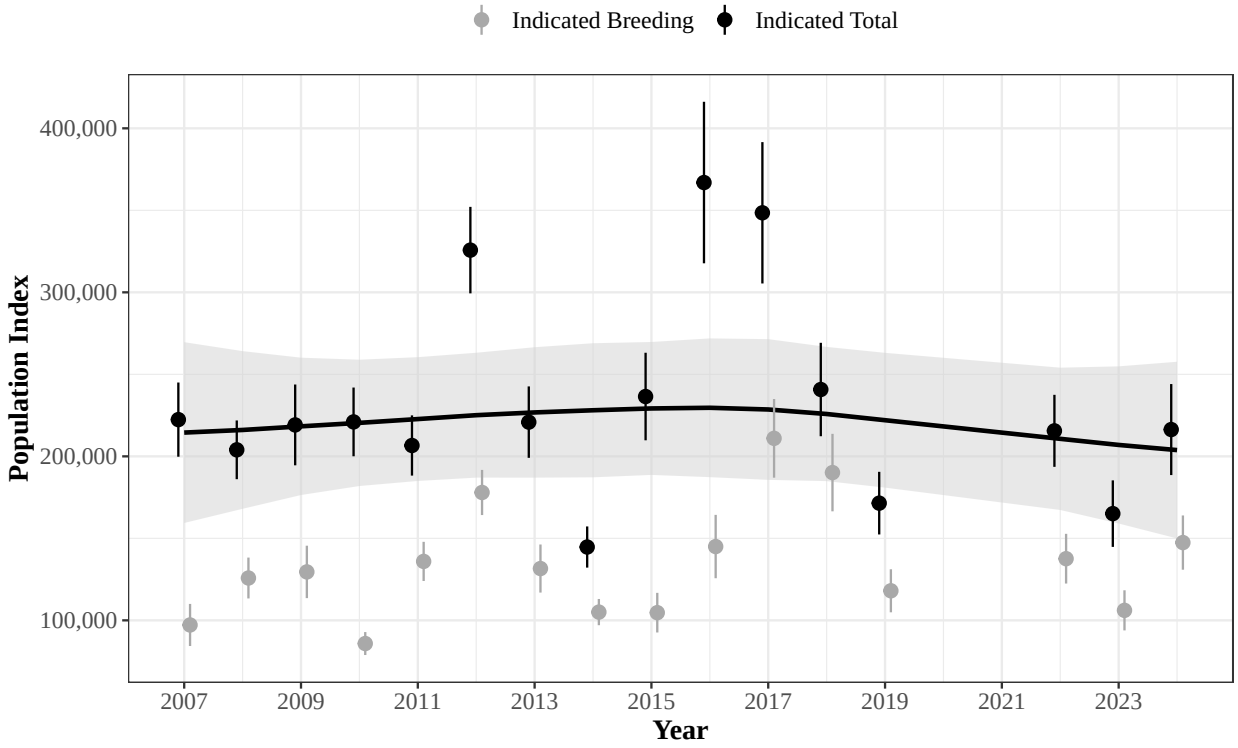

Figure 6: Greater white-fronted goose indices of indicated breeding birds (grey circles; 2 x [singles + pairs]) and indicated total birds (black circles; 2 x [singles + pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Greater White-fronted Goose

Table 4: Greater white-fronted goose indices of indicated breeding birds (2 x [singles + pairs]) and indicated total birds (2 x [singles + pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	97,186	6,543	222,391	11,545
2008	125,815	6,354	203,979	9,136
2009	129,536	8,153	219,158	12,572
2010	85,861	3,569	220,997	10,688
2011	135,945	6,091	206,622	9,365
2012	177,967	7,020	325,739	13,453
2013	131,591	7,477	220,865	11,108
2014	105,031	4,077	144,705	6,404
2015	104,689	6,165	236,474	13,620
2016	145,001	9,854	366,939	25,123
2017	210,980	12,239	348,491	21,987
2018	190,102	12,051	240,750	14,532
2019	118,028	6,693	171,468	9,741
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	137,603	7,732	215,556	11,199
2023	106,099	6,238	165,075	10,350
2024	147,420	8,434	216,333	14,158

Greater White-fronted Goose

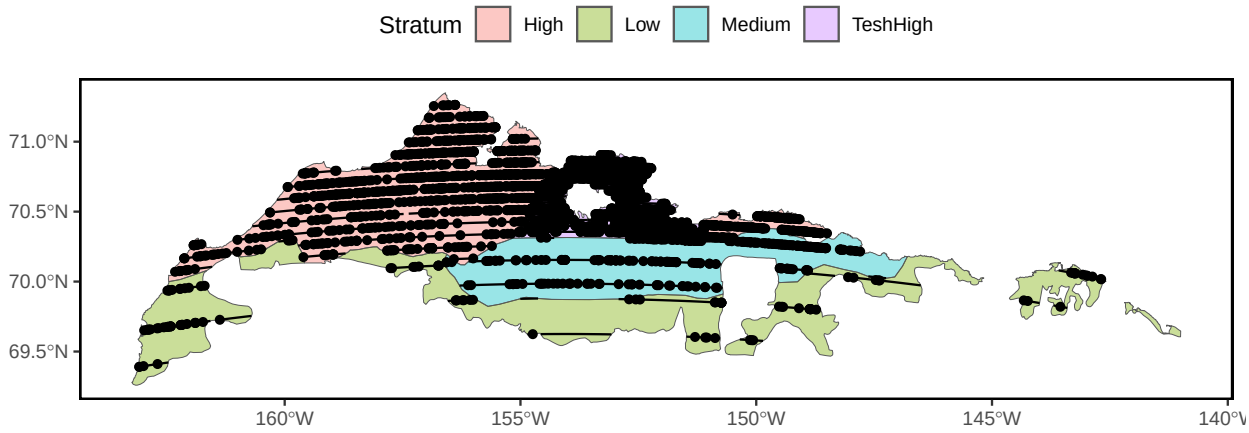

Figure 7: Observations of greater white-fronted geese along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Brant

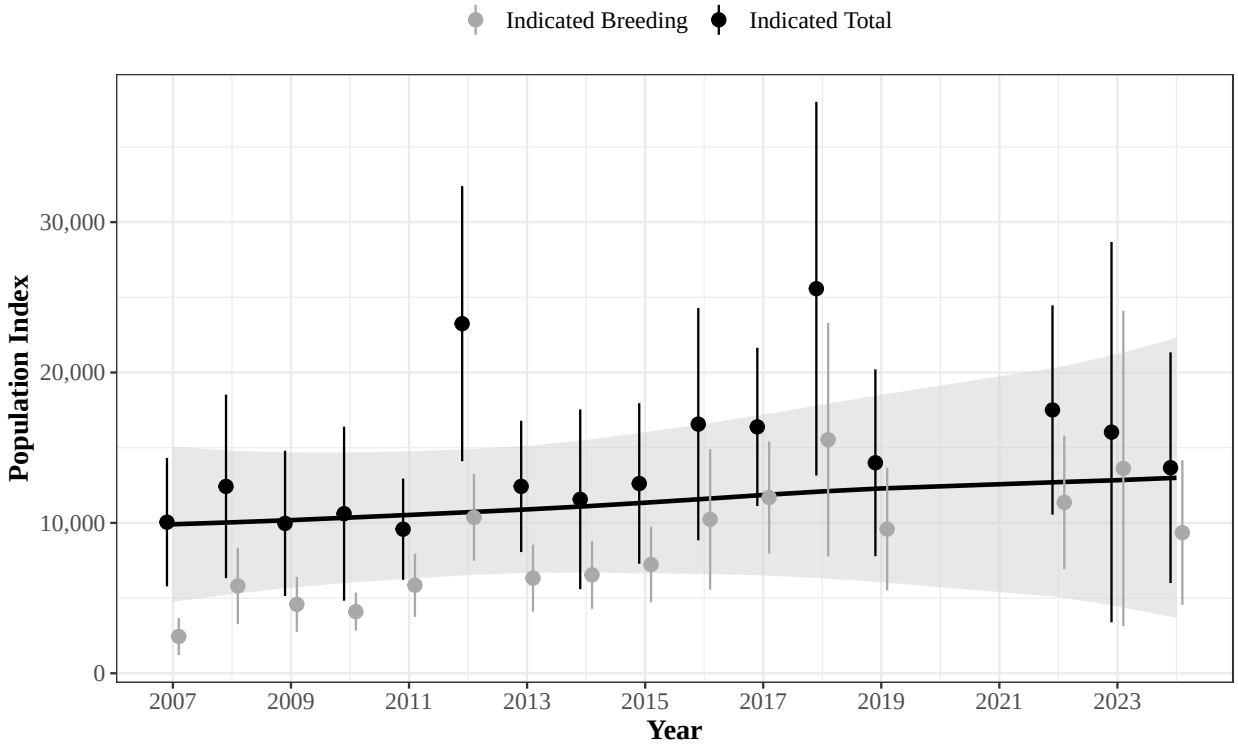

Figure 8: Brant indices of indicated breeding birds (grey circles; 2 x [singles + pairs]) and indicated total birds (black circles; 2 x [singles + pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Brant

Table 5: Brant indices of indicated breeding birds (2 x [singles + pairs]) and indicated total birds (2 x [singles + pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	2,447	628	10,049	2,178
2008	5,811	1,298	12,427	3,112
2009	4,582	935	9,969	2,464
2010	4,101	645	10,614	2,951
2011	5,856	1,073	9,583	1,718
2012	10,365	1,471	23,248	4,666
2013	6,327	1,139	12,428	2,228
2014	6,548	1,155	11,569	3,051
2015	7,232	1,282	12,620	2,723
2016	10,236	2,385	16,568	3,943
2017	11,686	1,897	16,386	2,684
2018	15,533	3,963	25,577	6,340
2019	9,588	2,081	13,998	3,169
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	11,363	2,263	17,510	3,551
2023	13,624	5,346	16,036	6,452
2024	9,354	2,451	13,670	3,914

Brant

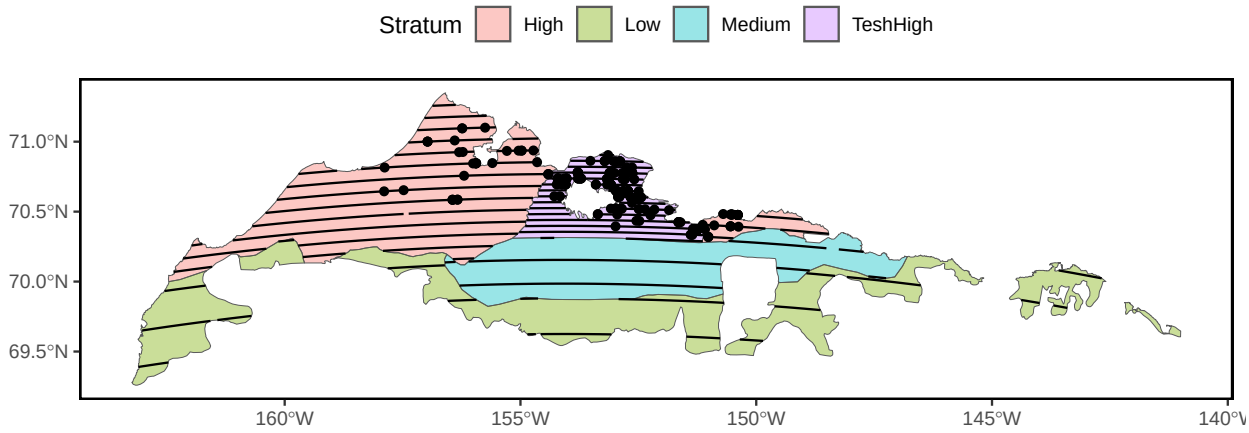

Figure 9: Observations of brant along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Cackling/Canada Goose

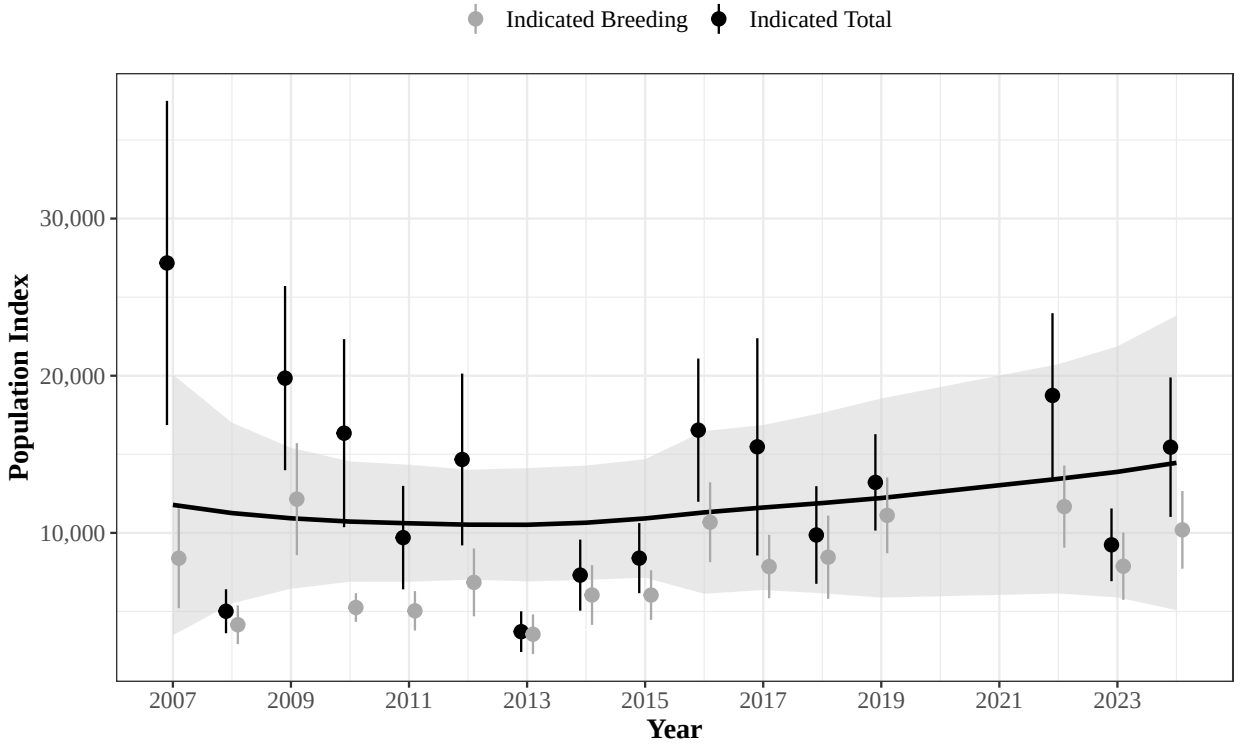

Figure 10: Cackling/Canada goose indices of indicated breeding birds (grey circles; 2 x [singles + pairs]) and indicated total birds (black circles; 2 x [singles + pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Cackling/Canada Goose

Table 6: Cackling/Canada goose indices of indicated breeding birds (2 x [singles + pairs]) and indicated total birds (2 x [singles + pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	8,384	1,620	27,175	5,263
2008	4,155	629	5,013	714
2009	12,149	1,818	19,847	2,989
2010	5,253	464	16,345	3,052
2011	5,041	639	9,699	1,679
2012	6,851	1,101	14,670	2,788
2013	3,551	645	3,714	660
2014	6,048	969	7,312	1,153
2015	6,043	804	8,393	1,138
2016	10,676	1,296	16,537	2,325
2017	7,856	1,029	15,476	3,527
2018	8,453	1,350	9,865	1,584
2019	11,115	1,231	13,214	1,564
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	11,672	1,331	18,746	2,671
2023	7,881	1,092	9,240	1,181
2024	10,191	1,261	15,453	2,264

Cackling/Canada Goose

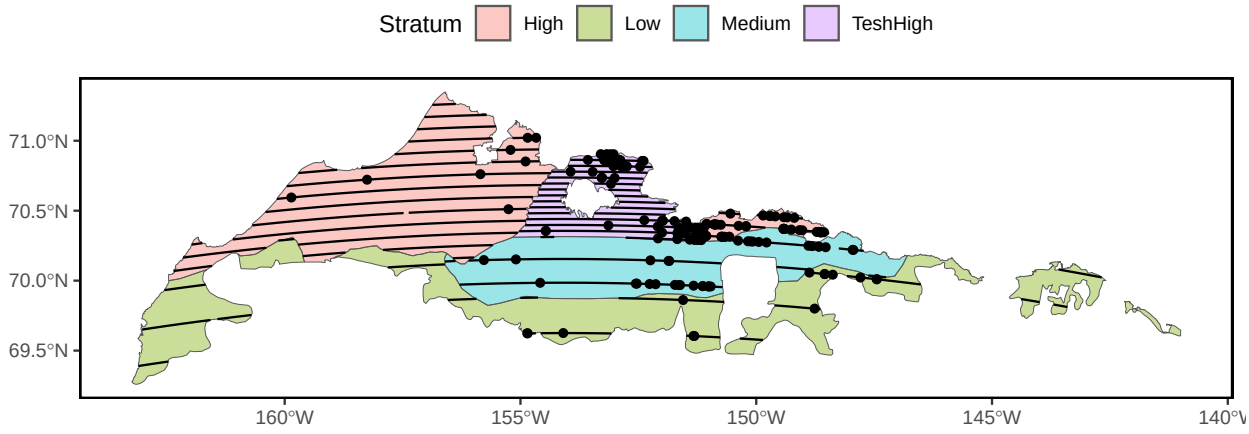

Figure 11: Observations of cackling/Canada geese along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Tundra Swan

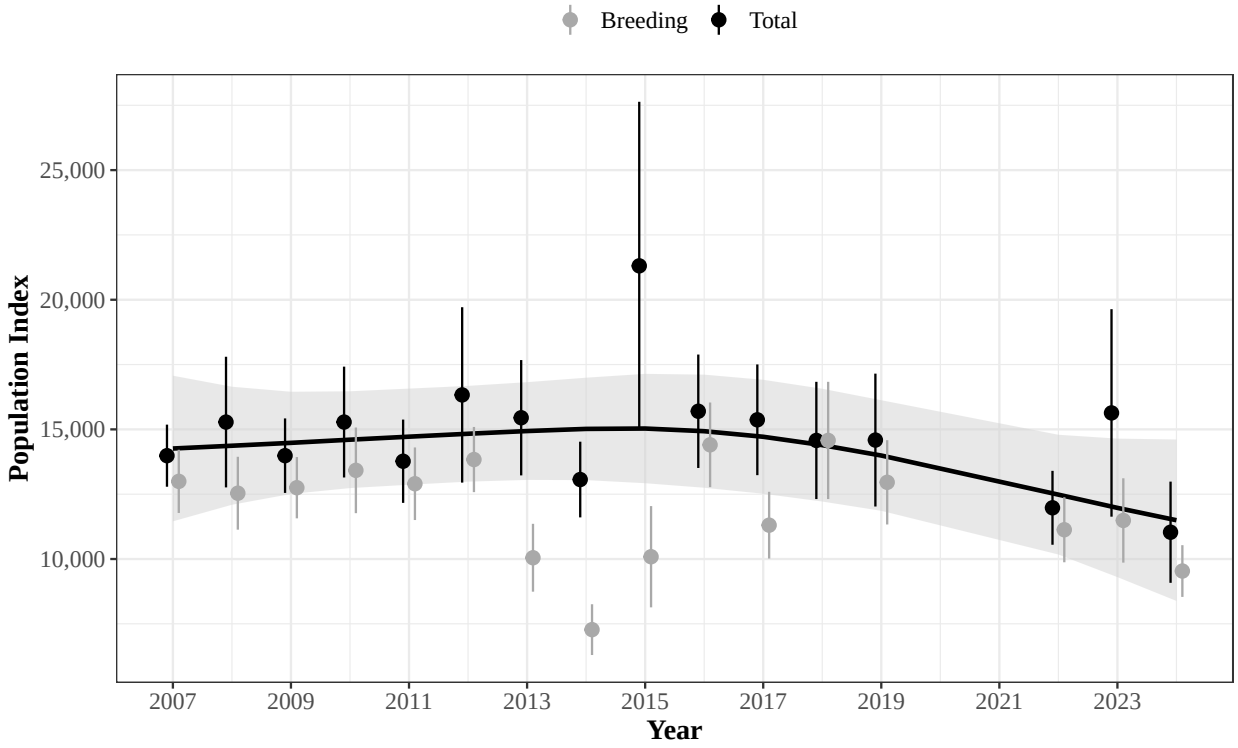

Figure 12: Tundra swan indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Tundra Swan

Table 7: Tundra swan indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	12,995	622	13,985	611
2008	12,537	717	15,281	1,286
2009	12,750	603	13,986	733
2010	13,420	843	15,282	1,091
2011	12,903	714	13,771	820
2012	13,836	641	16,329	1,726
2013	10,049	667	15,449	1,135
2014	7,275	499	13,065	745
2015	10,088	996	21,308	3,228
2016	14,404	832	15,699	1,116
2017	11,305	657	15,369	1,089
2018	14,573	1,154	14,573	1,154
2019	12,958	829	14,588	1,308
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	11,129	640	11,975	727
2023	11,487	830	15,634	2,042
2024	9,536	509	11,033	996

Tundra Swan

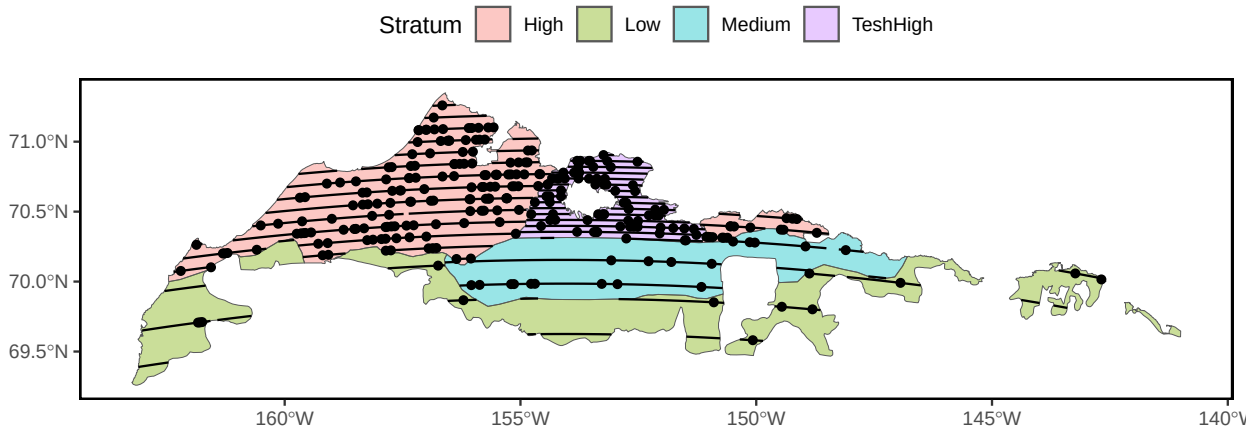

Figure 13: Observations of tundra swans along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Northern Shoveler

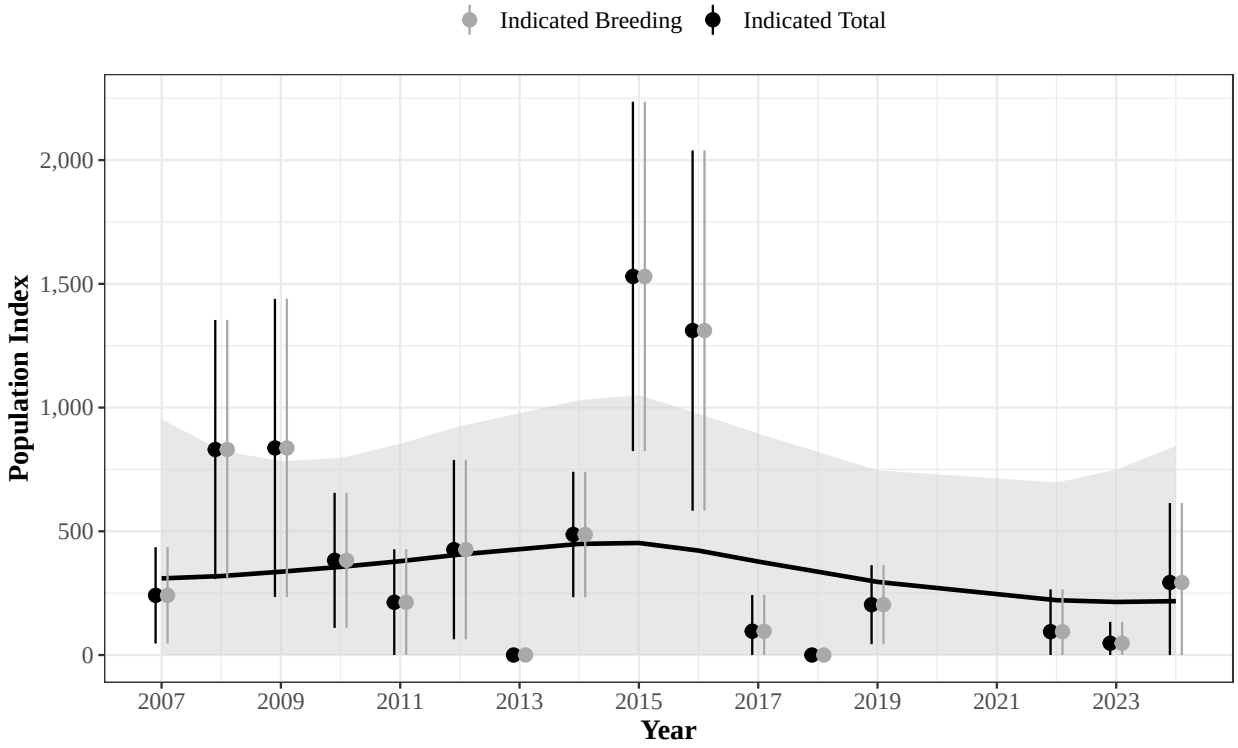

Figure 14: Northern shoveler indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Northern Shoveler

Table 8: Northern shoveler indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	241	99	241	99
2008	831	267	831	267
2009	837	307	837	307
2010	383	139	383	139
2011	213	109	213	109
2012	426	185	426	185
2013	0	0	0	0
2014	487	129	487	129
2015	1,530	360	1,530	360
2016	1,311	371	1,311	371
2017	96	75	96	75
2018	0	0	0	0
2019	204	82	204	82
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	94	87	94	87
2023	48	44	48	44
2024	293	164	293	164

Northern Shoveler

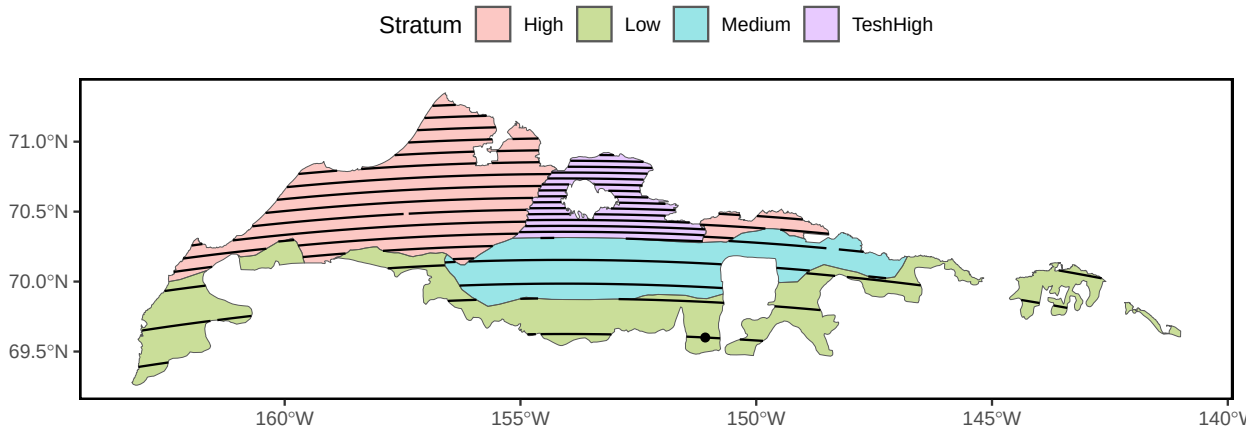

Figure 15: Observations of northern shoveler along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

American Wigeon

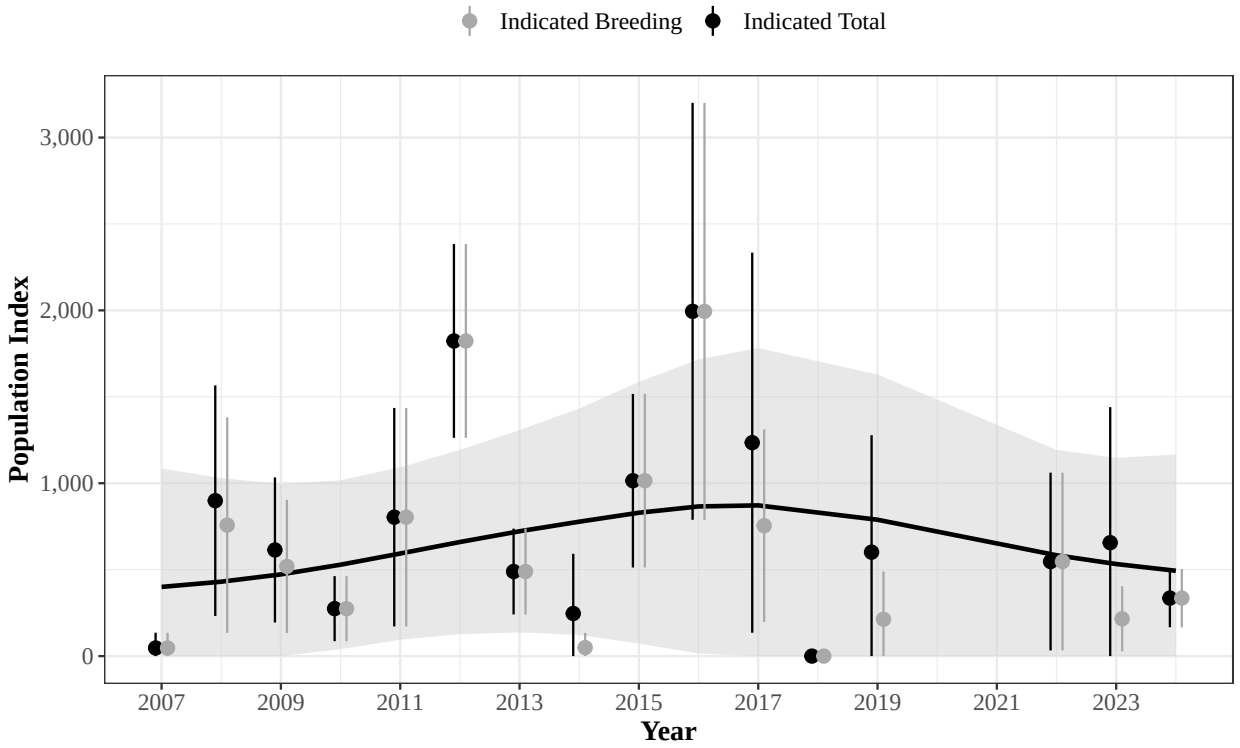

Figure 16: American wigeon indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

American Wigeon

Table 9: American wigeon indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	47	45	47	45
2008	758	318	899	340
2009	519	197	614	214
2010	274	96	274	96
2011	804	322	804	322
2012	1,823	286	1,823	286
2013	489	127	489	127
2014	49	43	246	176
2015	1,015	256	1,015	256
2016	1,994	615	1,994	615
2017	754	284	1,235	561
2018	0	0	0	0
2019	213	141	601	345
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	547	262	547	262
2023	216	96	656	400
2024	335	86	335	86

American Wigeon

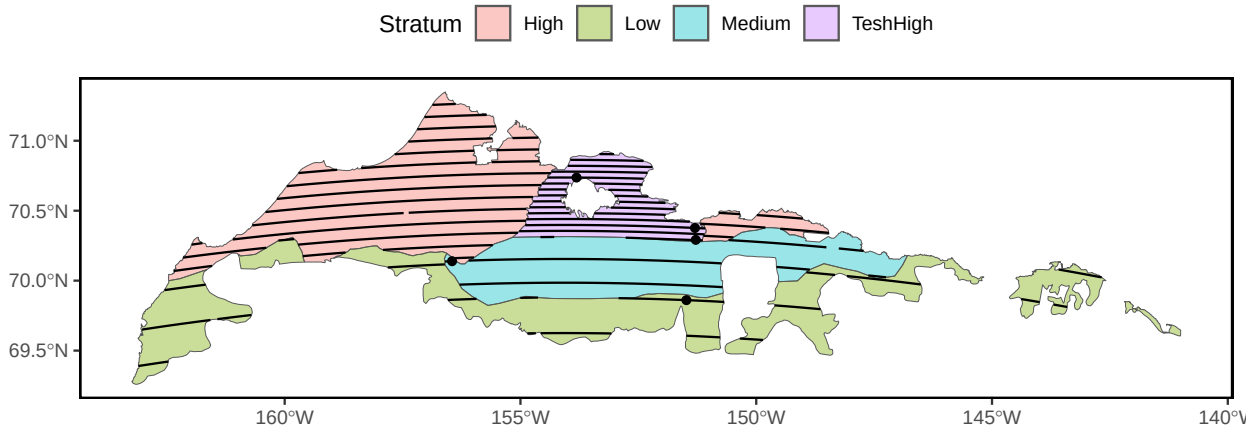

Figure 17: Observations of American wigeon along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Mallard

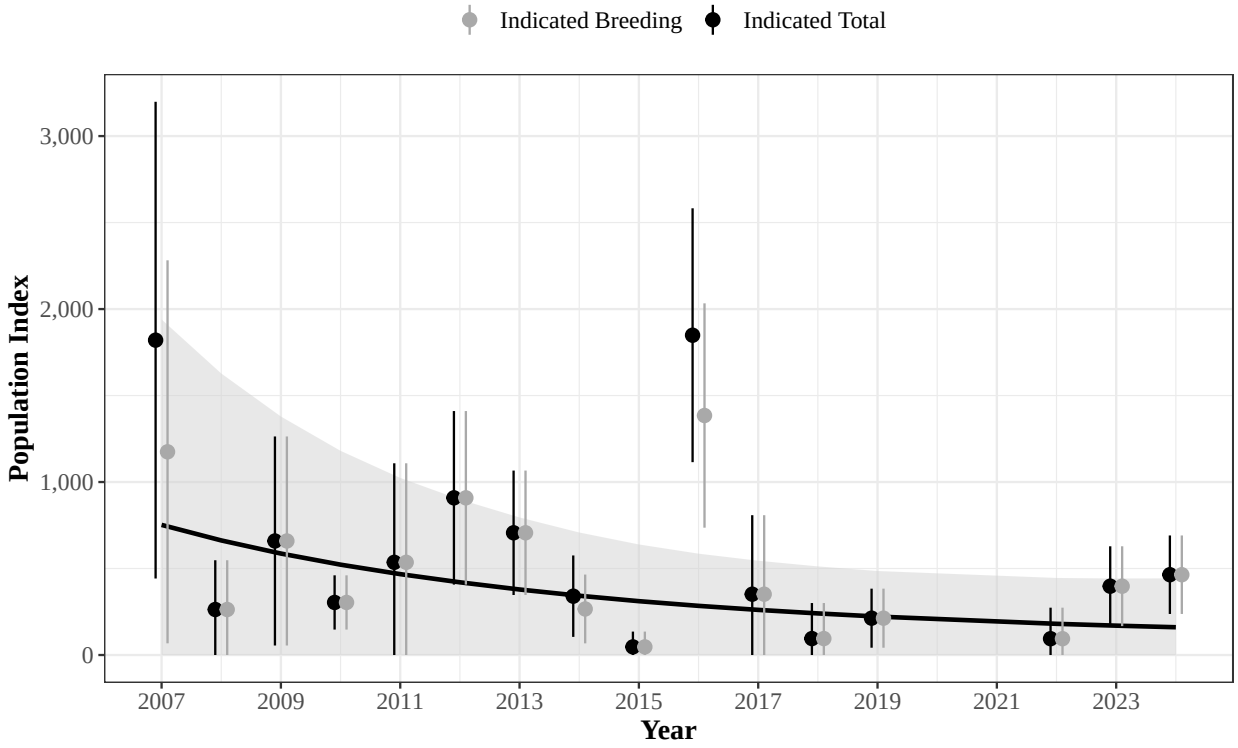

Figure 18: Mallard indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Mallard

Table 10: Mallard indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	1,175	565	1,820	703
2008	263	145	263	145
2009	659	308	659	308
2010	304	80	304	80
2011	536	292	536	292
2012	909	256	909	256
2013	707	183	707	183
2014	266	101	340	120
2015	47	45	47	45
2016	1,385	331	1,849	374
2017	352	233	352	233
2018	95	105	95	105
2019	213	87	213	87
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	94	92	94	92
2023	398	118	398	118
2024	464	116	464	116

Mallard

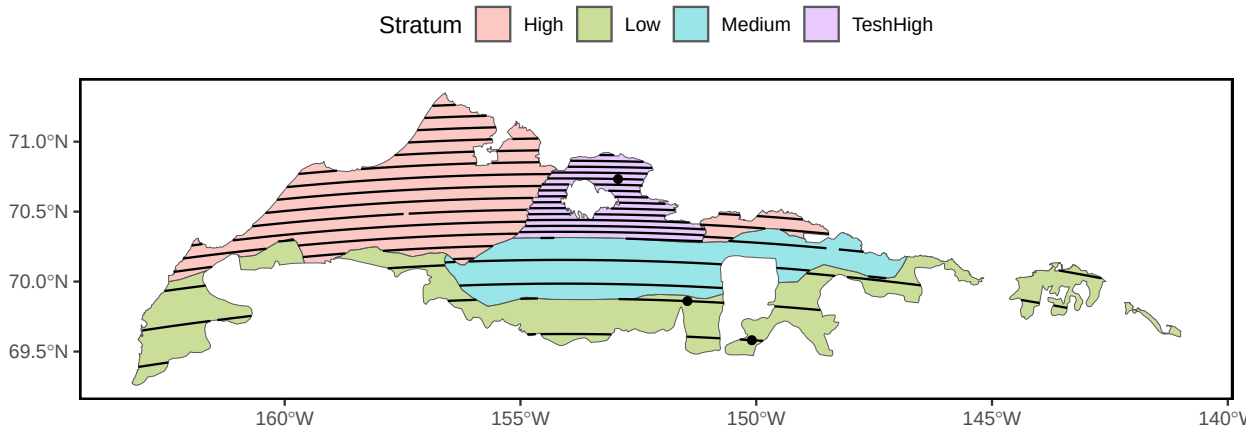

Figure 19: Observations of mallards along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Northern Pintail

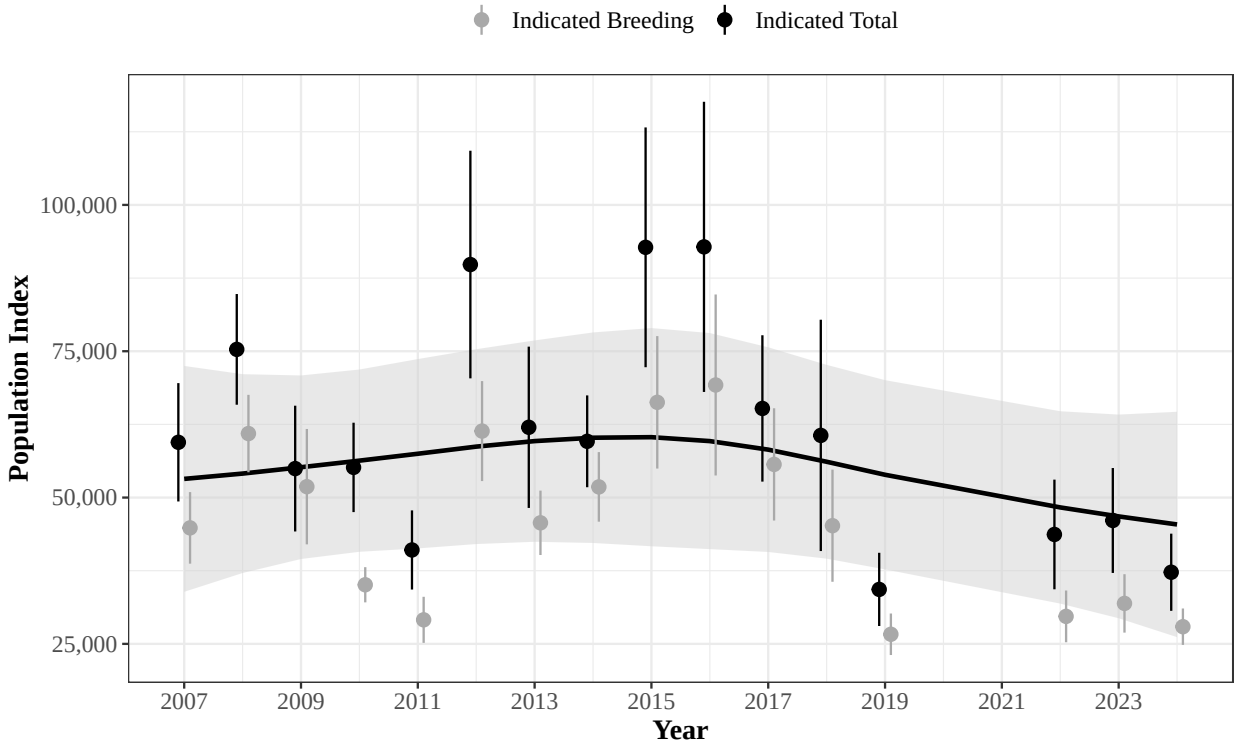

Figure 20: Northern pintail indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Northern Pintail

Table 11: Northern pintail indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	44,819	3,119	59,442	5,159
2008	60,935	3,374	75,316	4,825
2009	51,861	5,030	54,949	5,482
2010	35,099	1,534	55,152	3,896
2011	29,109	2,008	41,046	3,450
2012	61,357	4,357	89,812	9,921
2013	45,684	2,806	62,006	7,031
2014	51,818	3,031	59,608	4,003
2015	66,271	5,773	92,754	10,452
2016	69,234	7,889	92,833	12,646
2017	55,664	4,893	65,226	6,379
2018	45,194	4,887	60,621	10,084
2019	26,641	1,808	34,306	3,191
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	29,698	2,255	43,695	4,781
2023	31,915	2,546	46,083	4,573
2024	27,934	1,586	37,240	3,362

Northern Pintail

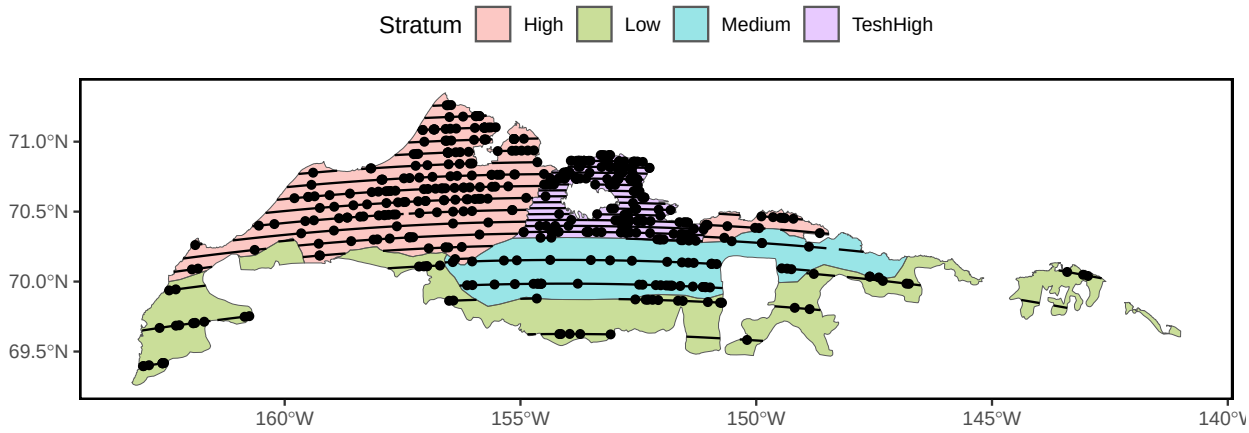

Figure 21: Observations of northern pintails along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

American Green-winged Teal

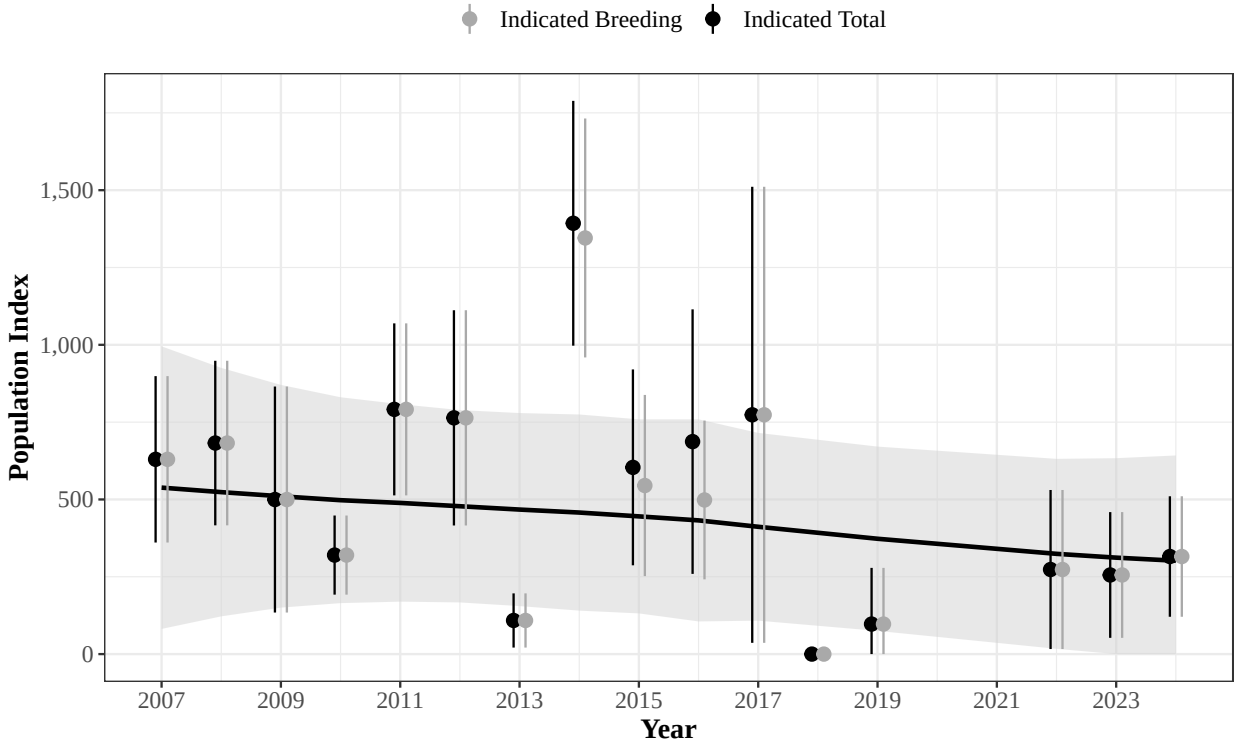

Figure 22: American green-winged teal indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

American Green-winged Teal

Table 12: American green-winged teal indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	630	137	630	137
2008	682	136	682	136
2009	500	186	500	186
2010	320	65	320	65
2011	791	142	791	142
2012	764	178	764	178
2013	109	45	109	45
2014	1,345	197	1,393	202
2015	545	149	604	162
2016	498	131	687	218
2017	774	376	774	376
2018	0	0	0	0
2019	97	93	97	93
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	273	131	273	131
2023	256	104	256	104
2024	316	99	316	99

American Green-winged Teal

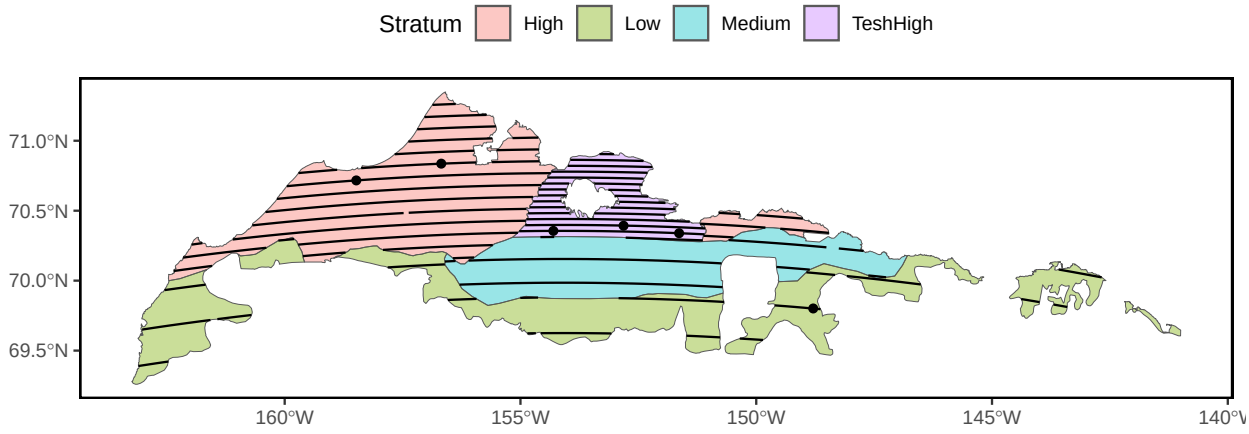

Figure 23: Observations of American green-winged teal along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Scaup species

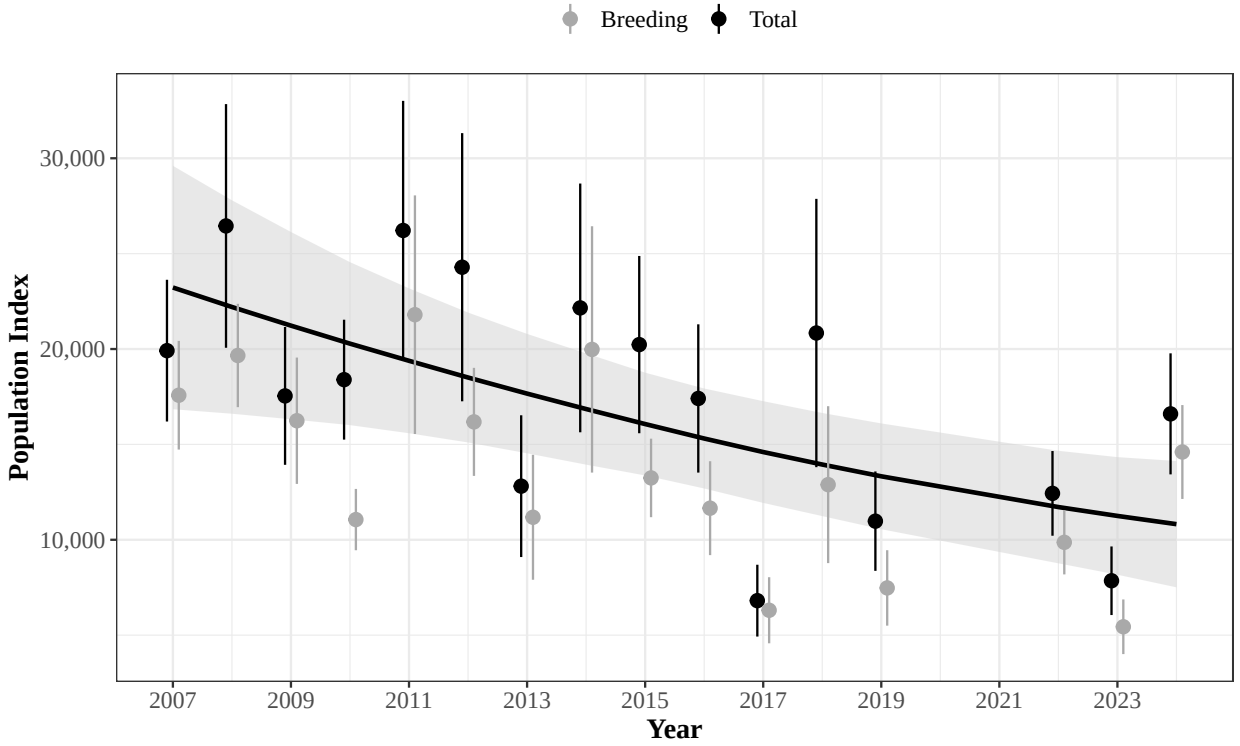

Figure 24: Scaup species indices of breeding birds (grey circles; singles + [2 x pairs] + flocked drakes <5) and total birds (black circles; singles + [2 x pairs] + flocked drakes <5 + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Scaup species

Table 13: Scaup species indices of breeding birds (singles + [2 x pairs] + flocked drakes <5) and total birds (singles + [2 x pairs] + flocked drakes <5 + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	17,578	1,453	19,914	1,895
2008	19,661	1,382	26,453	3,259
2009	16,241	1,689	17,542	1,843
2010	11,058	820	18,394	1,603
2011	21,799	3,191	26,215	3,466
2012	16,181	1,445	24,288	3,586
2013	11,180	1,671	12,811	1,896
2014	19,979	3,294	22,155	3,327
2015	13,242	1,050	20,232	2,371
2016	11,656	1,256	17,408	1,983
2017	6,305	884	6,809	961
2018	12,889	2,098	20,839	3,588
2019	7,476	1,009	10,975	1,329
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	9,866	858	12,432	1,133
2023	5,439	731	7,852	917
2024	14,601	1,255	16,601	1,619

Scaup species

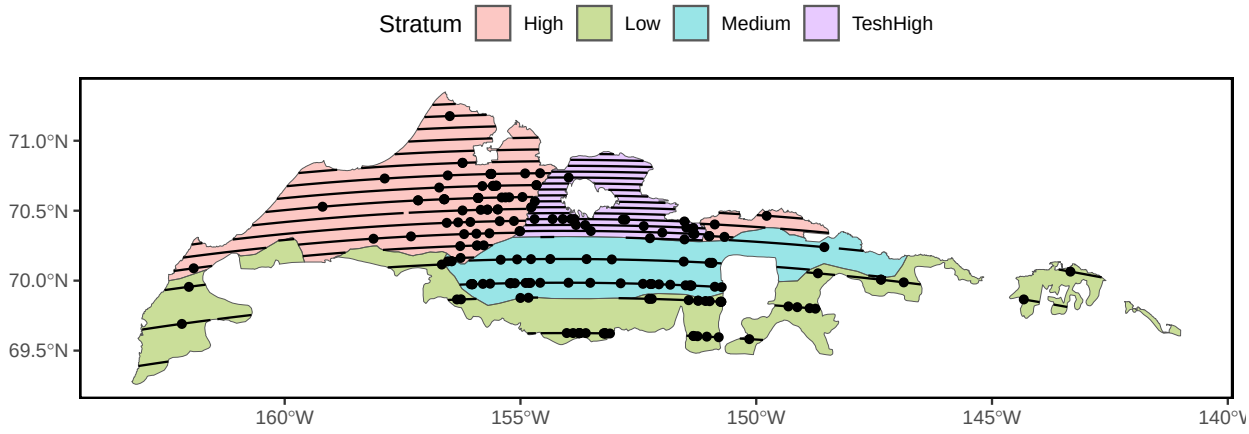

Figure 25: Observations of scaup species along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Steller's Eider

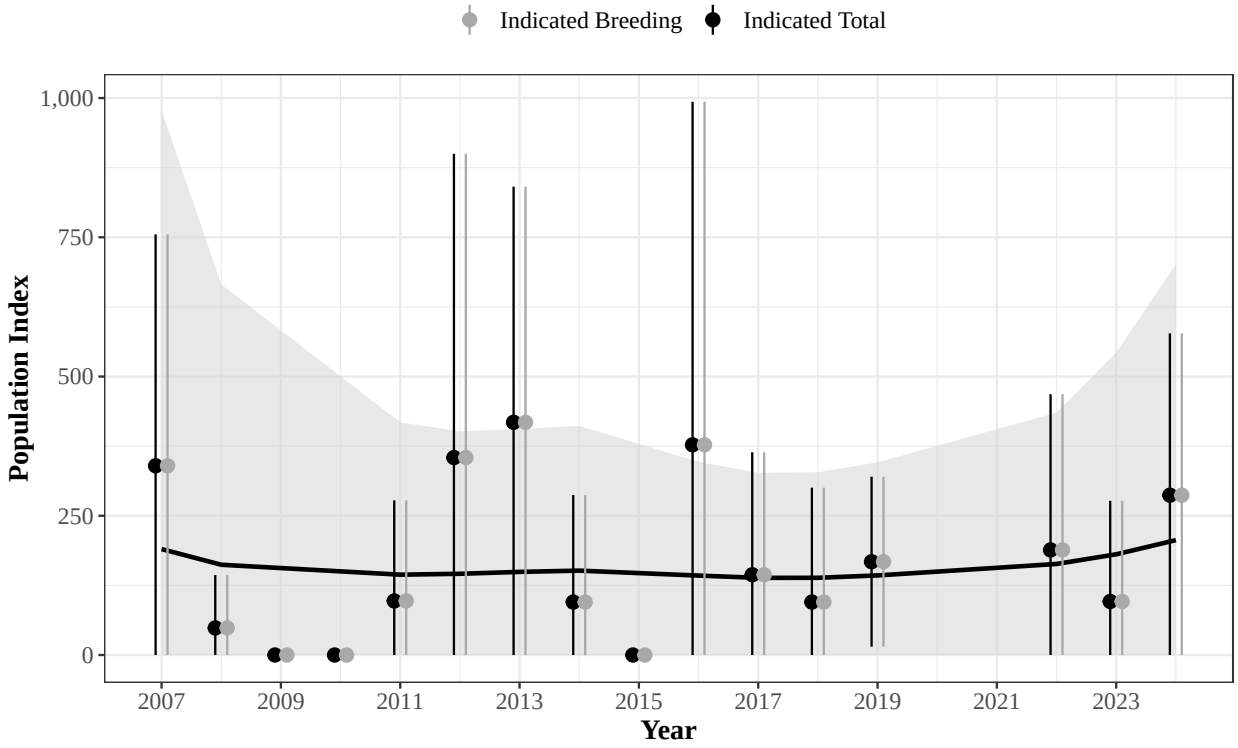

Figure 26: Steller's eider indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Steller's Eider

Table 14: Steller's eider indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	340	212	340	212
2008	49	48	49	48
2009	0	0	0	0
2010	0	0	0	0
2011	97	92	97	92
2012	355	278	355	278
2013	418	216	418	216
2014	95	98	95	98
2015	0	0	0	0
2016	377	314	377	314
2017	144	112	144	112
2018	95	105	95	105
2019	168	78	168	78
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	189	143	189	143
2023	96	92	96	92
2024	287	148	287	148

Steller's Eider

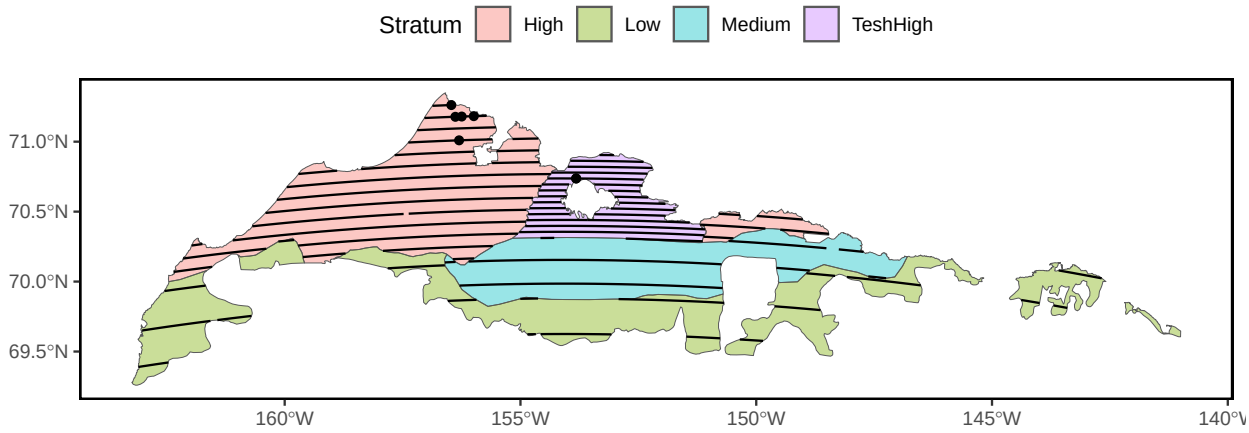

Figure 27: Observations of Steller's eiders along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Spectacled Eider

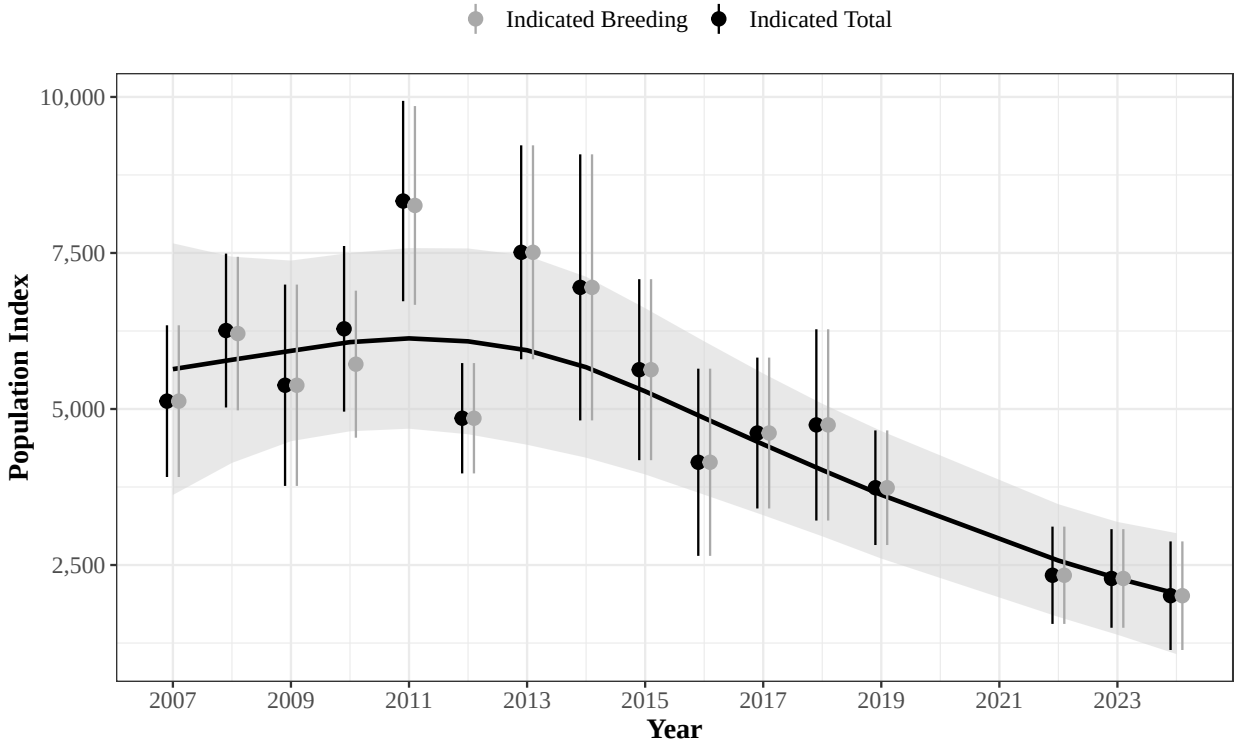

Figure 28: Spectacled eider indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Spectacled Eider

Table 15: Spectacled eider indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	5,126	620	5,126	620
2008	6,208	628	6,257	629
2009	5,380	823	5,380	823
2010	5,718	601	6,285	677
2011	8,261	812	8,332	819
2012	4,852	451	4,852	451
2013	7,511	874	7,511	874
2014	6,949	1,088	6,949	1,088
2015	5,630	740	5,630	740
2016	4,147	765	4,147	765
2017	4,615	617	4,615	617
2018	4,745	782	4,745	782
2019	3,739	468	3,739	468
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	2,336	398	2,336	398
2023	2,285	403	2,285	403
2024	2,009	444	2,009	444

Spectacled Eider

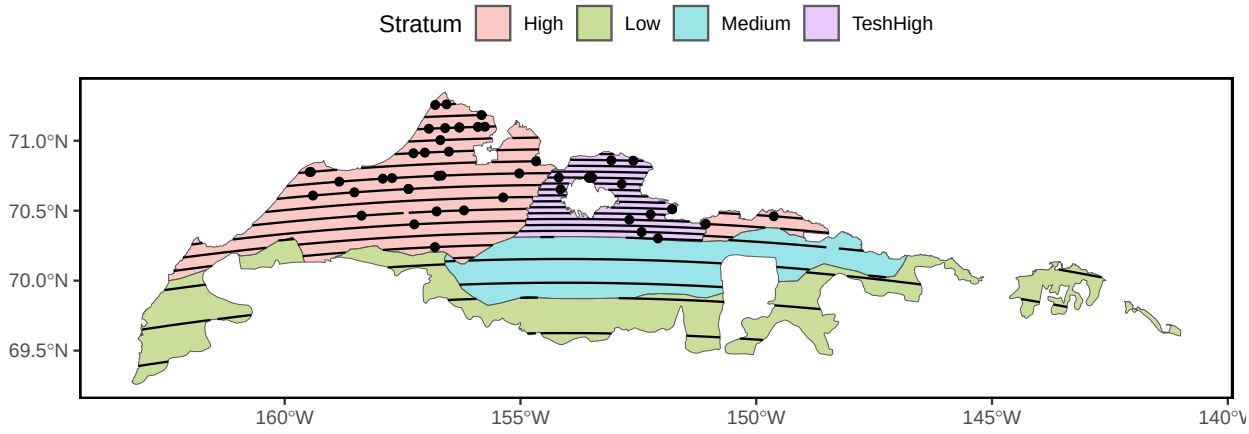

Figure 29: Observations of spectacled eiders along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

King Eider

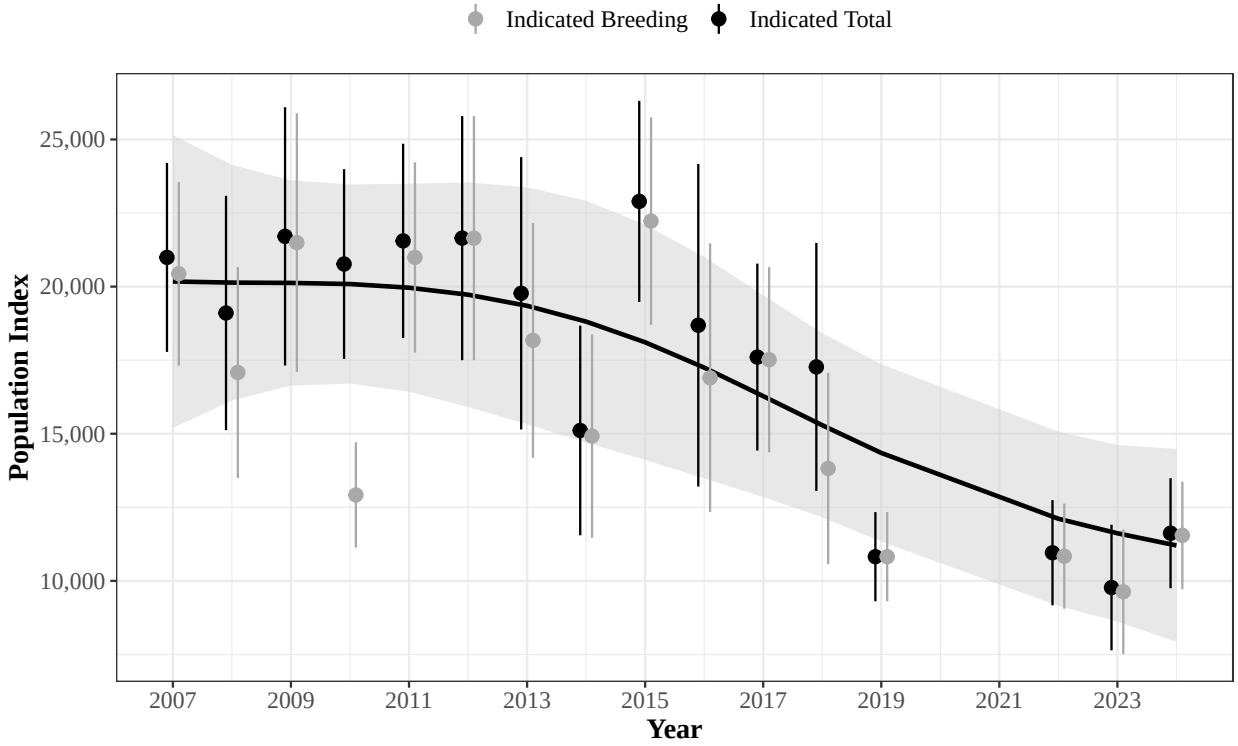

Figure 30: King eider indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

King Eider

Table 16: King eider indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	20,437	1,594	20,992	1,638
2008	17,082	1,828	19,103	2,031
2009	21,493	2,242	21,707	2,239
2010	12,921	913	20,767	1,645
2011	20,992	1,650	21,554	1,685
2012	21,647	2,115	21,647	2,115
2013	18,172	2,035	19,773	2,361
2014	14,921	1,762	15,111	1,817
2015	22,226	1,798	22,894	1,743
2016	16,901	2,329	18,687	2,797
2017	17,516	1,604	17,604	1,620
2018	13,821	1,659	17,271	2,150
2019	10,823	773	10,823	773
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	10,839	911	10,957	912
2023	9,630	1,080	9,774	1,089
2024	11,549	931	11,620	953

King Eider

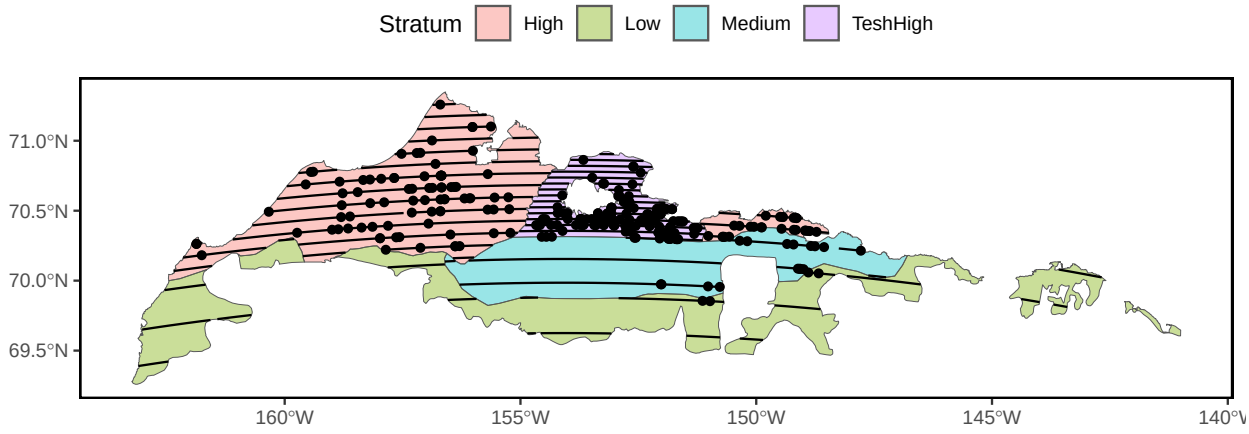

Figure 31: Observations of king eiders along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Common Eider

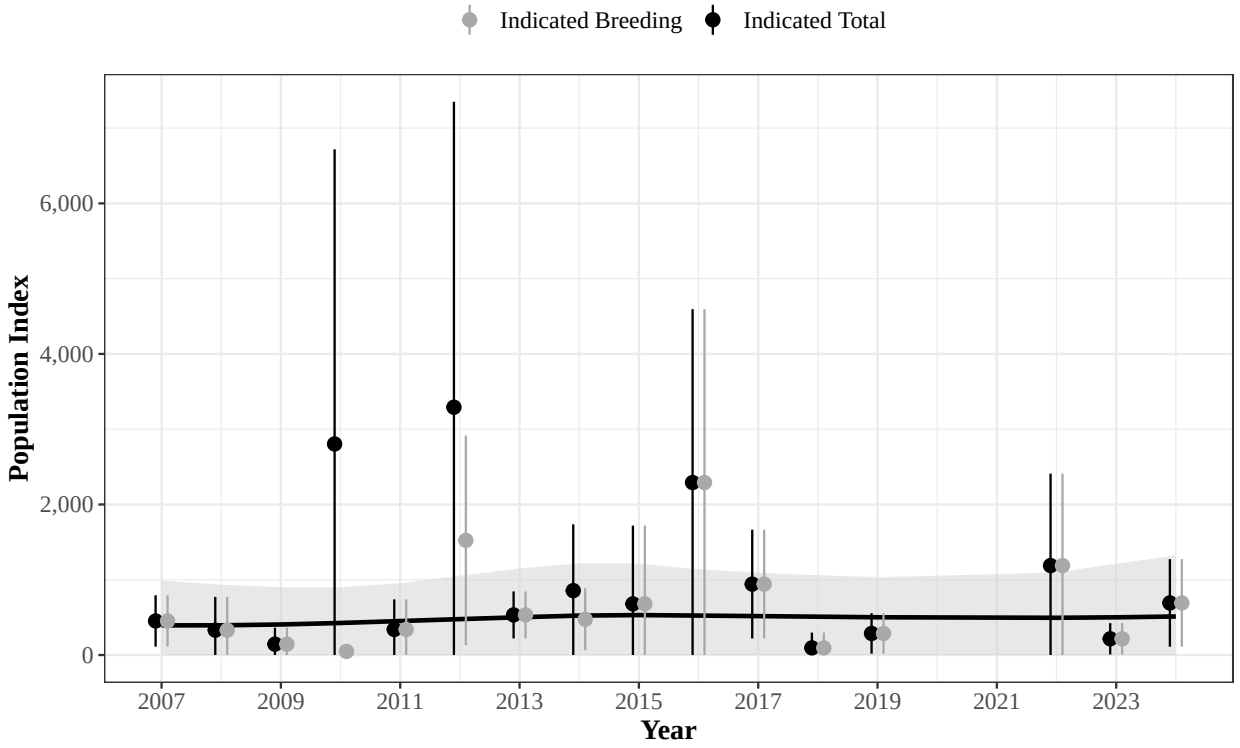

Figure 32: Common eider indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Common Eider

Table 17: Common eider indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	453	174	453	174
2008	330	225	330	225
2009	144	111	144	111
2010	48	47	2,804	1,997
2011	340	204	340	204
2012	1,523	710	3,292	2,070
2013	533	159	533	159
2014	475	210	855	449
2015	679	530	679	530
2016	2,292	1,175	2,292	1,175
2017	942	369	942	369
2018	95	104	95	104
2019	287	137	287	137
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	1,188	623	1,188	623
2023	216	106	216	106
2024	692	297	692	297

Common Eider

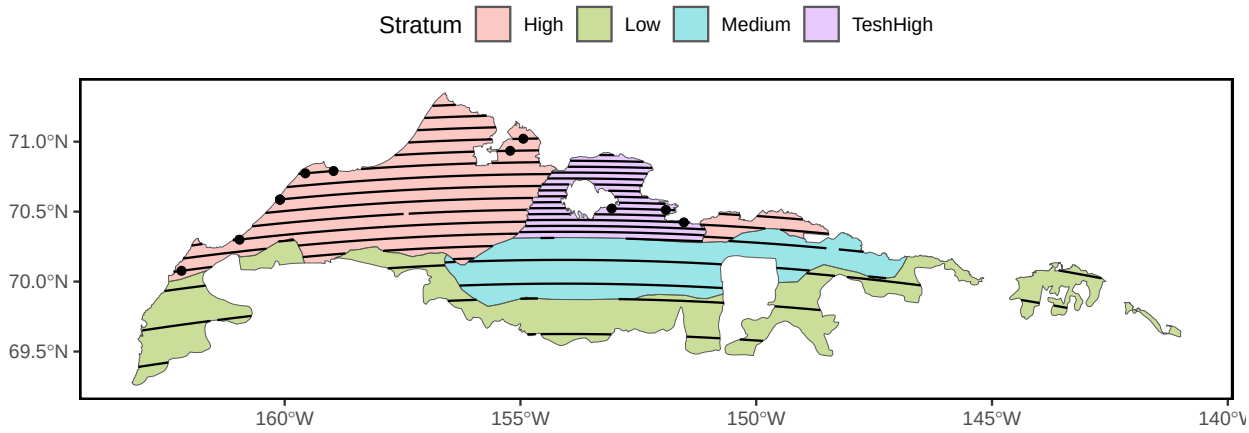

Figure 33: Observations of common eiders along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Surf Scoter

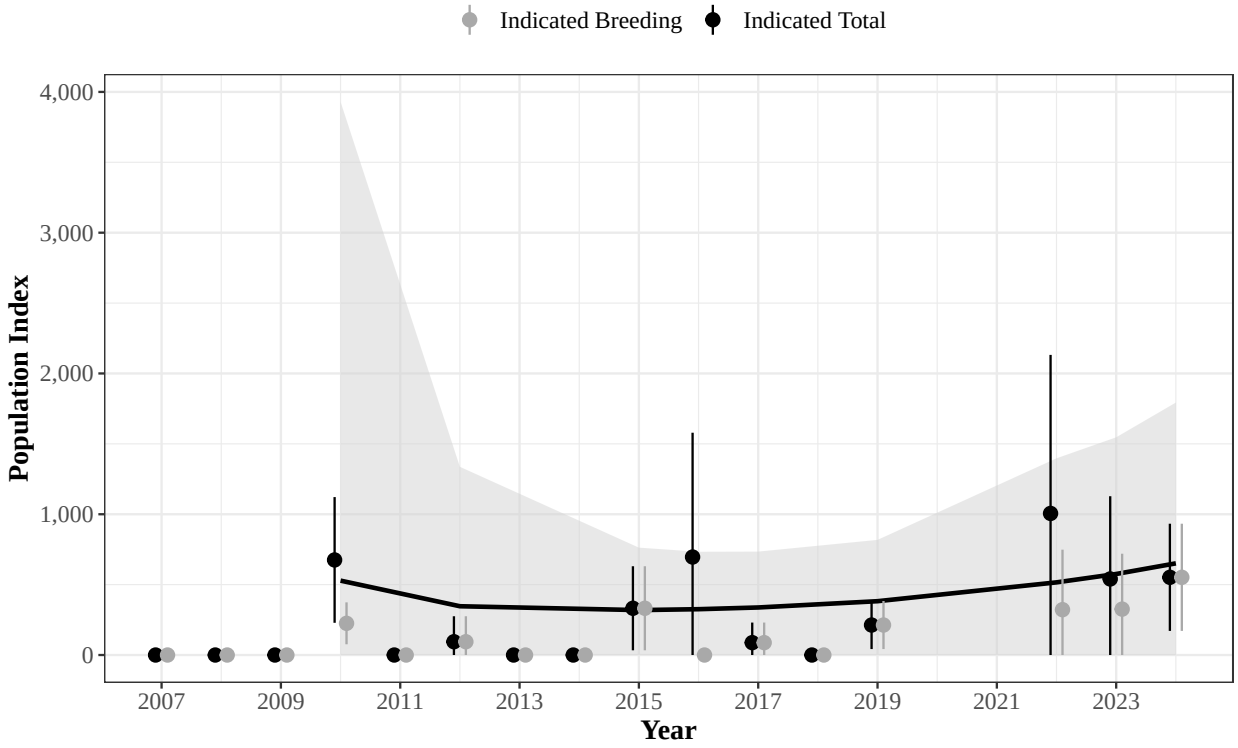

Figure 34: Surf scoter indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Surf Scoter

Table 18: Surf scoter indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	0	0	0	0
2008	0	0	0	0
2009	0	0	0	0
2010	225	76	675	228
2011	0	0	0	0
2012	94	92	94	92
2013	0	0	0	0
2014	0	0	0	0
2015	332	152	332	152
2016	0	0	696	450
2017	88	73	88	73
2018	0	0	0	0
2019	213	87	213	87
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	322	217	1,006	575
2023	326	201	540	300
2024	552	194	552	194

Surf Scoter

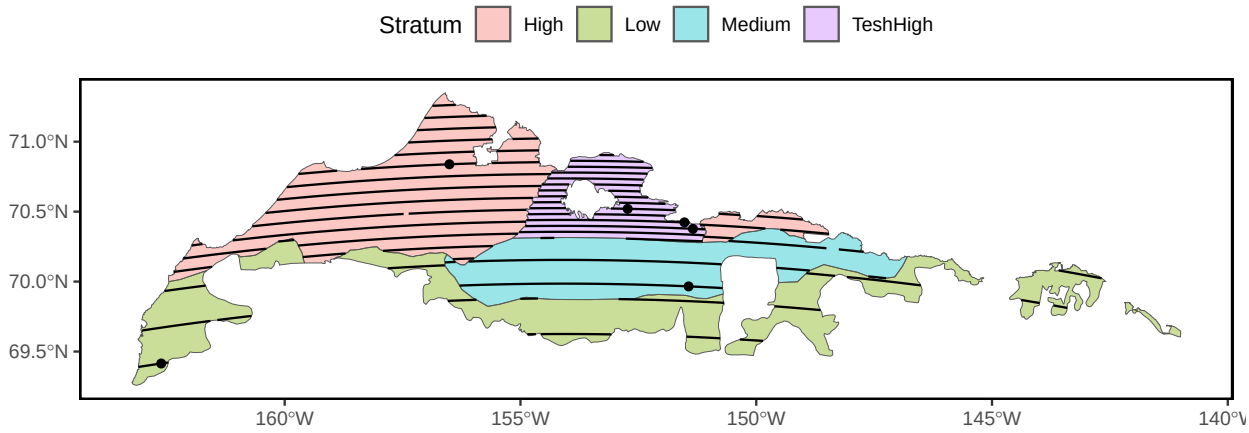

Figure 35: Observations of surf scoters along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

White-winged Scoter

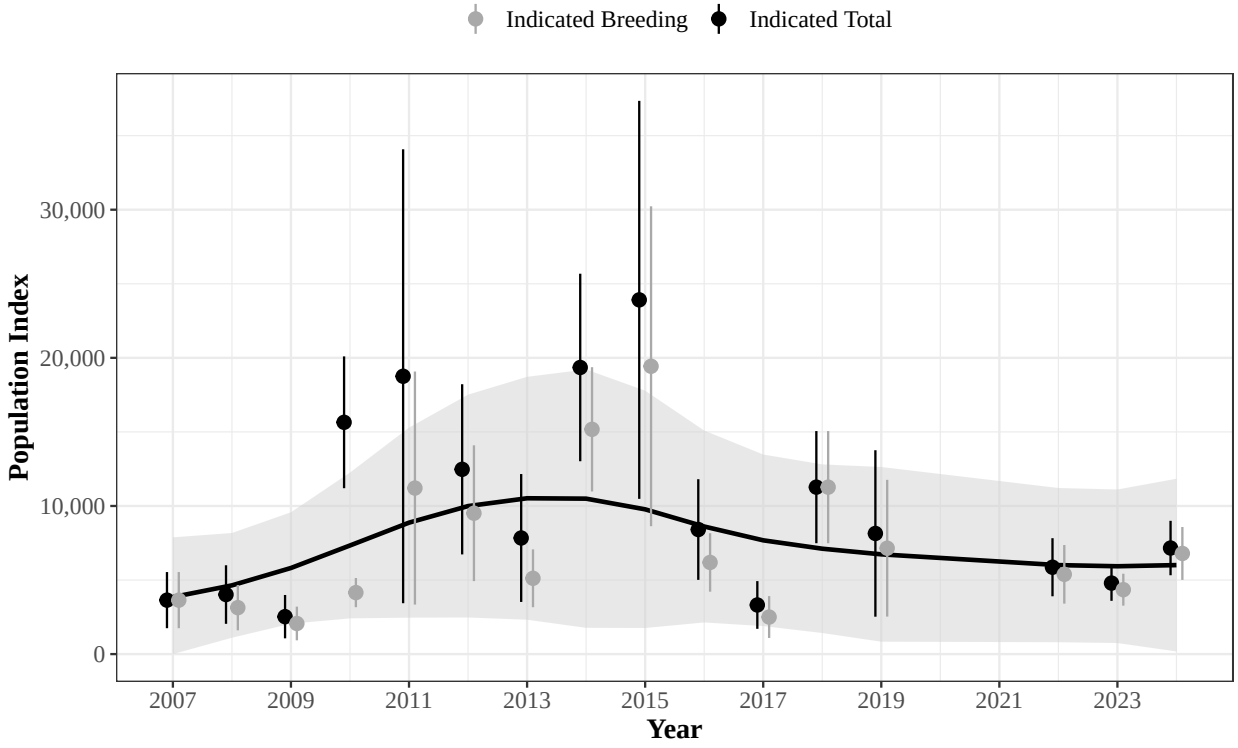

Figure 36: White-winged scoter indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

White-winged Scoter

Table 19: White-winged scoter indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	3,642	967	3,642	967
2008	3,136	780	4,020	1,009
2009	2,065	580	2,527	747
2010	4,152	503	15,648	2,270
2011	11,209	4,013	18,757	7,817
2012	9,510	2,339	12,473	2,931
2013	5,117	996	7,838	2,203
2014	15,174	2,140	19,350	3,230
2015	19,432	5,509	23,914	6,854
2016	6,188	1,007	8,409	1,734
2017	2,501	721	3,316	822
2018	11,270	1,932	11,270	1,932
2019	7,148	2,355	8,144	2,867
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	5,385	1,009	5,863	1,001
2023	4,348	550	4,793	611
2024	6,794	911	7,160	937

White-winged Scoter

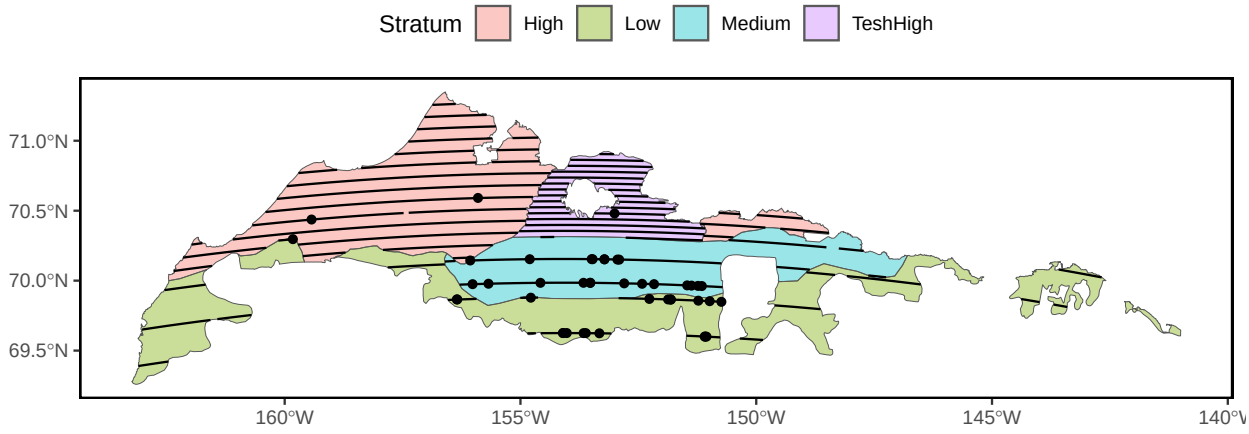

Figure 37: Observations of white-winged scoters along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Black Scoter

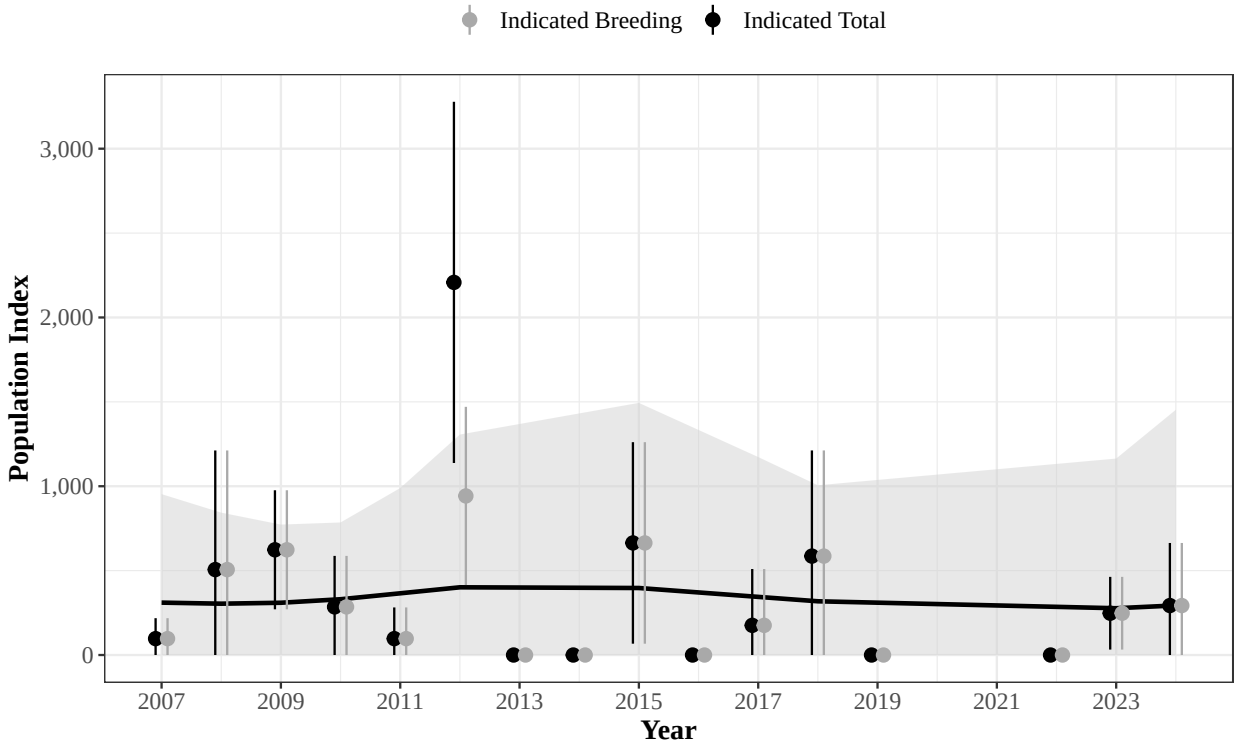

Figure 38: Black scoter indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Black Scoter

Table 20: Black scoter indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	97	62	97	62
2008	506	360	506	360
2009	623	180	623	180
2010	285	154	285	154
2011	97	94	97	94
2012	943	269	2,208	546
2013	0	0	0	0
2014	0	0	0	0
2015	664	305	664	305
2016	0	0	0	0
2017	176	170	176	170
2018	586	319	586	319
2019	0	0	0	0
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	0	0	0	0
2023	248	110	248	110
2024	293	189	293	189

Black Scoter

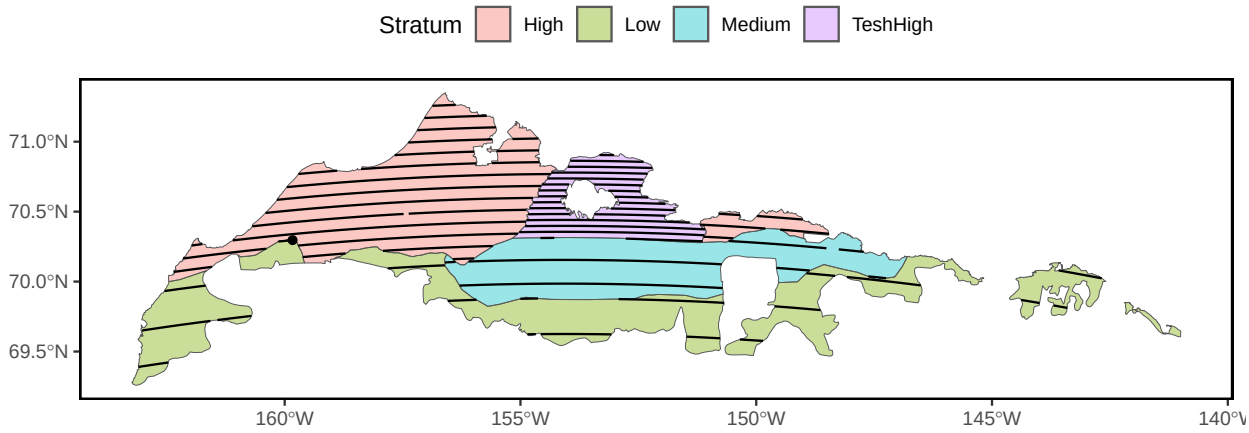

Figure 39: Observations of black scoters along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Long-tailed Duck

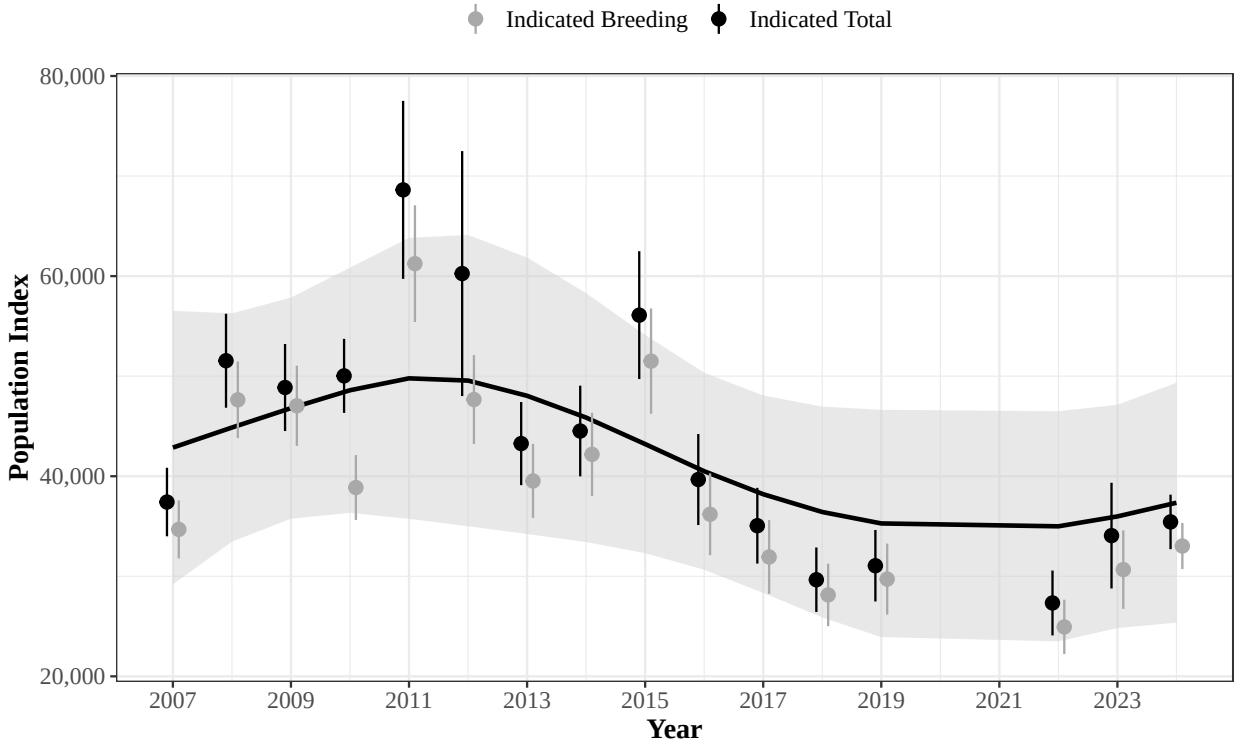

Figure 40: Long-tailed duck indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Long-tailed Duck

Table 21: Long-tailed duck indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	34,687	1,482	37,421	1,747
2008	47,636	1,954	51,545	2,395
2009	47,042	2,042	48,868	2,220
2010	38,869	1,653	50,030	1,888
2011	61,245	2,975	68,619	4,539
2012	47,666	2,266	60,256	6,246
2013	39,529	1,882	43,265	2,120
2014	42,187	2,120	44,520	2,312
2015	51,505	2,684	56,100	3,259
2016	36,197	2,088	39,672	2,320
2017	31,930	1,880	35,055	1,931
2018	28,140	1,596	29,656	1,644
2019	29,719	1,813	31,056	1,822
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	24,940	1,385	27,333	1,654
2023	30,669	2,002	34,065	2,695
2024	33,024	1,175	35,434	1,389

Long-tailed Duck

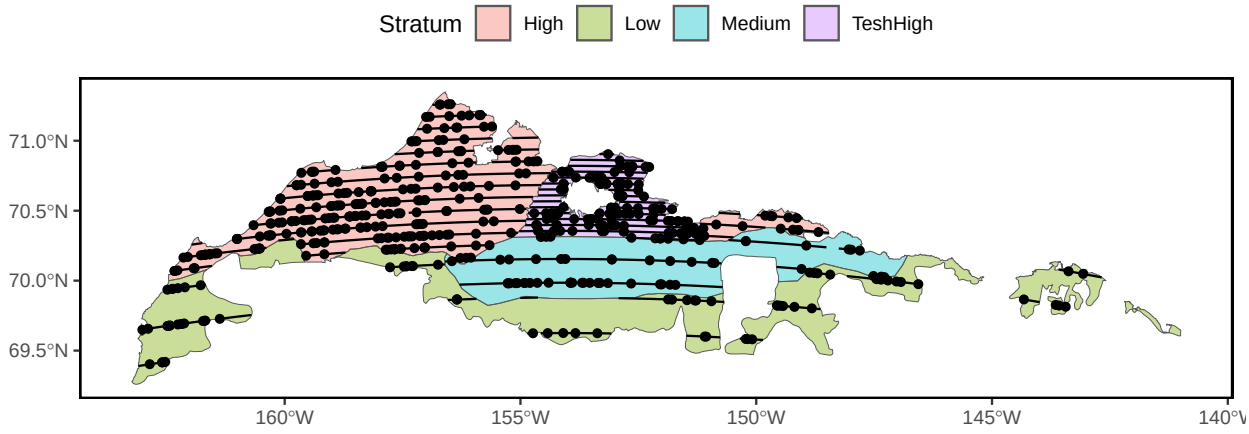

Figure 41: Observations of long-tailed ducks along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Red-breasted Merganser

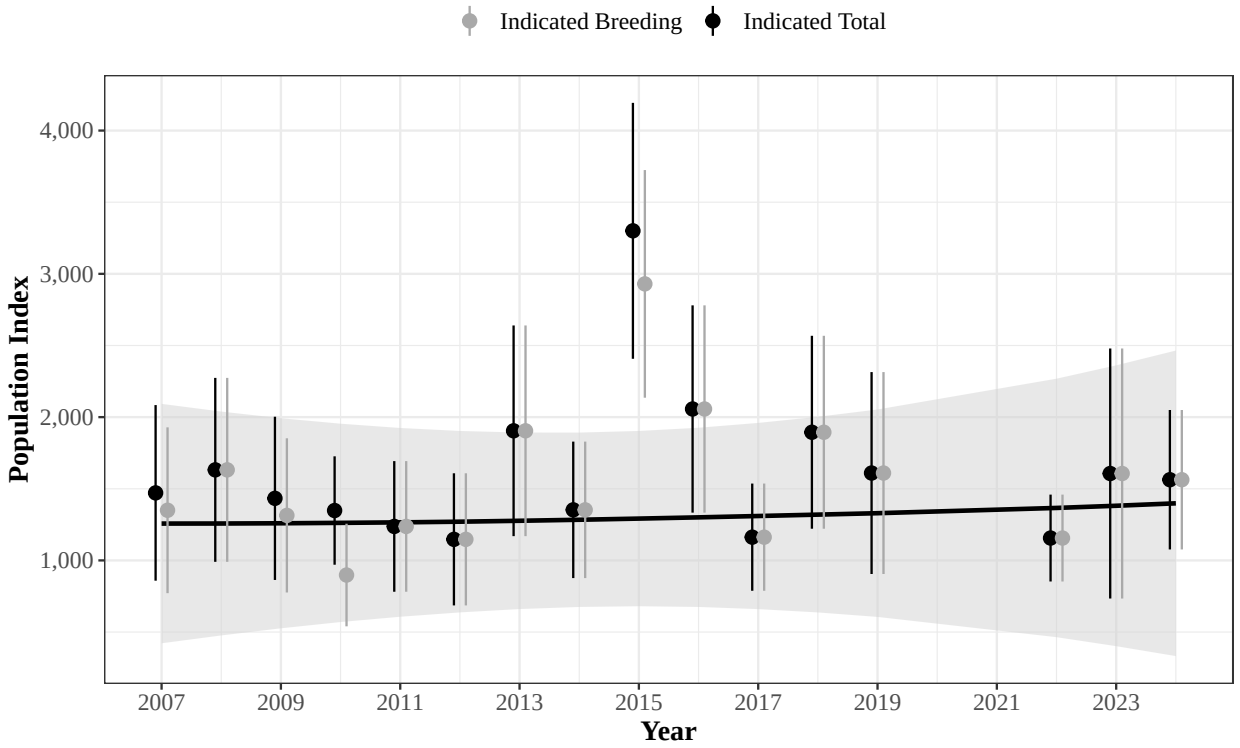

Figure 42: Red-breasted merganser indices of indicated breeding birds (grey circles; 2 x [singles + pairs + flocked drakes <5]) and indicated total birds (black circles; 2 x [singles + pairs + flocked drakes <5] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Red-breasted Merganser

Table 22: Red-breasted merganser indices of indicated breeding birds (2 x [singles + pairs + flocked drakes <5]) and indicated total birds (2 x [singles + pairs + flocked drakes <5] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	1,350	295	1,471	313
2008	1,632	327	1,632	327
2009	1,314	275	1,433	291
2010	898	183	1,348	193
2011	1,237	233	1,237	233
2012	1,147	235	1,147	235
2013	1,905	375	1,905	375
2014	1,353	243	1,353	243
2015	2,930	405	3,300	456
2016	2,057	369	2,057	369
2017	1,162	191	1,162	191
2018	1,894	344	1,894	344
2019	1,610	360	1,610	360
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	1,156	155	1,156	155
2023	1,607	445	1,607	445
2024	1,563	248	1,563	248

Red-breasted Merganser

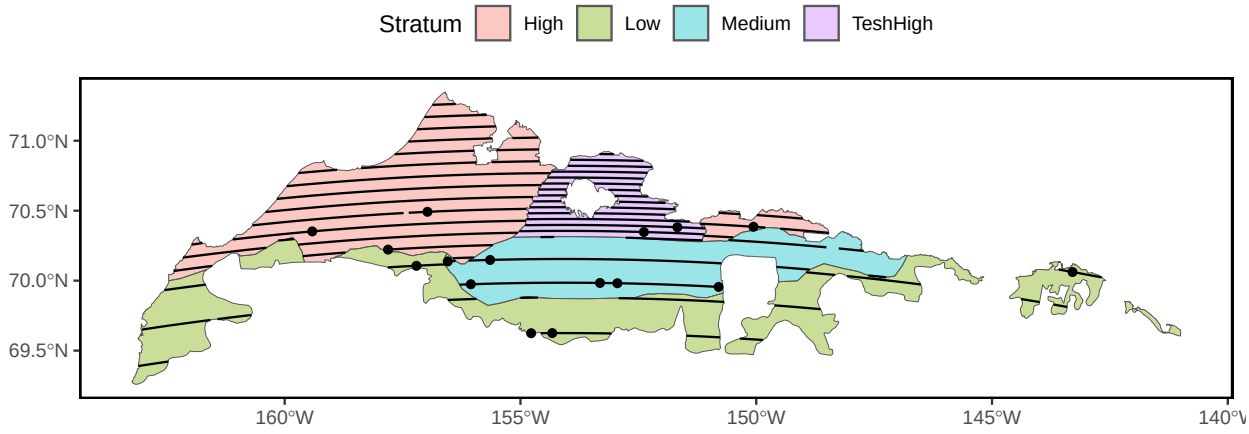

Figure 43: Observations of red-breasted mergansers along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Red-necked Grebe

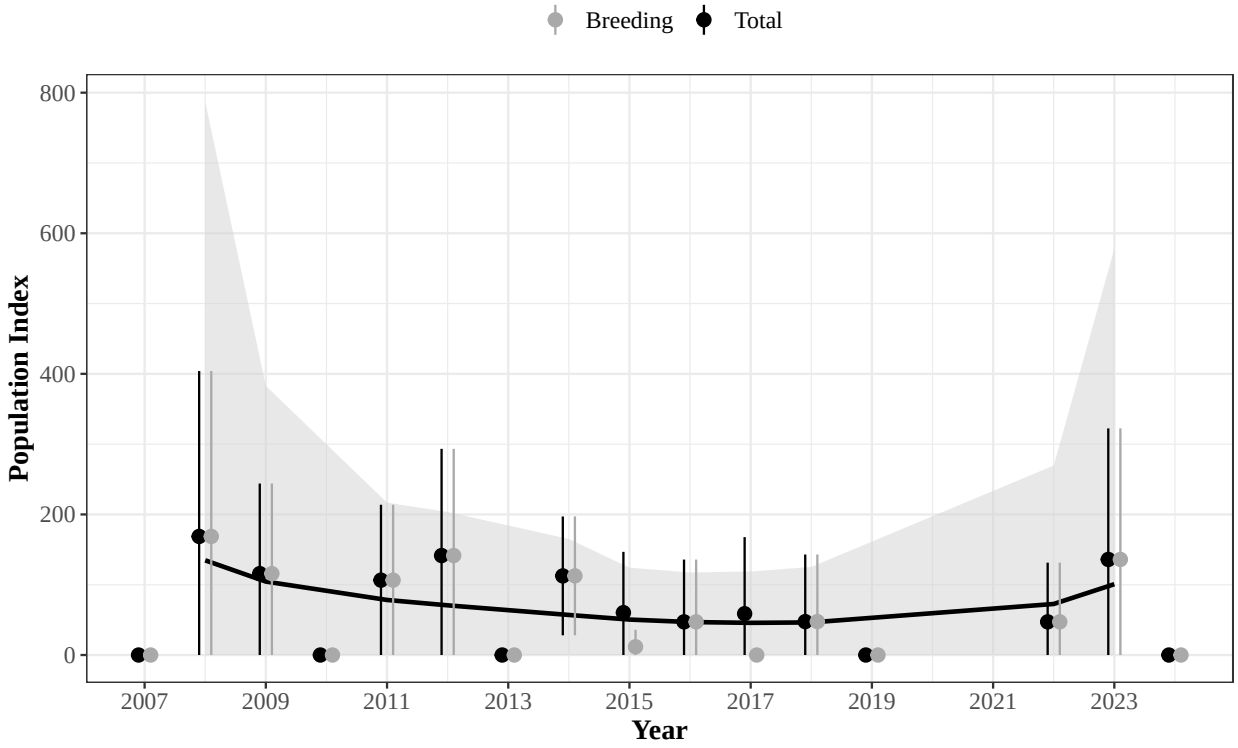

Figure 44: Red-necked grebe indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Red-necked Grebe

Table 23: Red-necked grebe indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	0	0	0	0
2008	169	120	169	120
2009	116	65	116	65
2010	0	0	0	0
2011	106	55	106	55
2012	142	77	142	77
2013	0	0	0	0
2014	113	43	113	43
2015	12	12	60	44
2016	47	45	47	45
2017	0	0	59	56
2018	48	49	48	49
2019	0	0	0	0
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	47	43	47	43
2023	136	95	136	95
2024	0	0	0	0

Red-necked Grebe

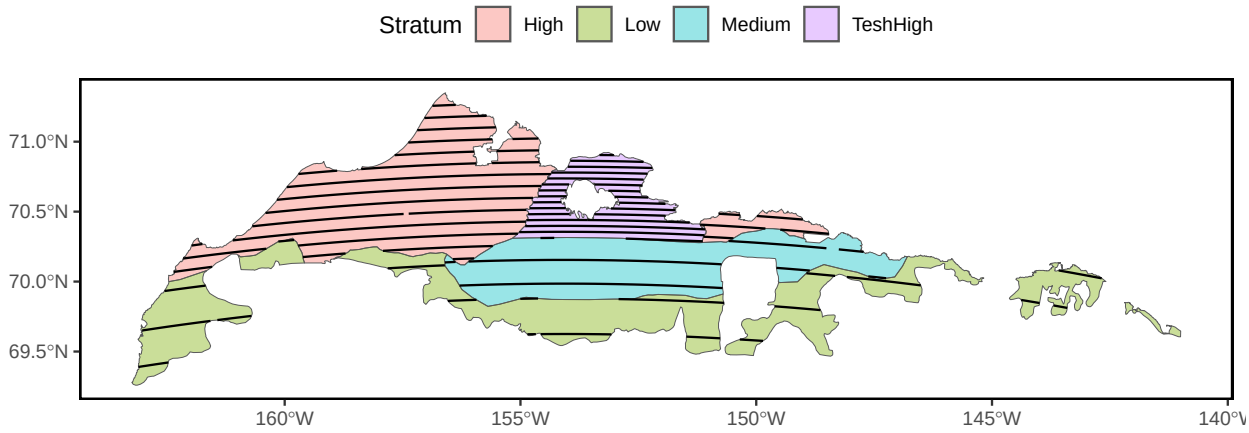

Figure 45: Observations of red-necked grebes along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Sandhill Crane

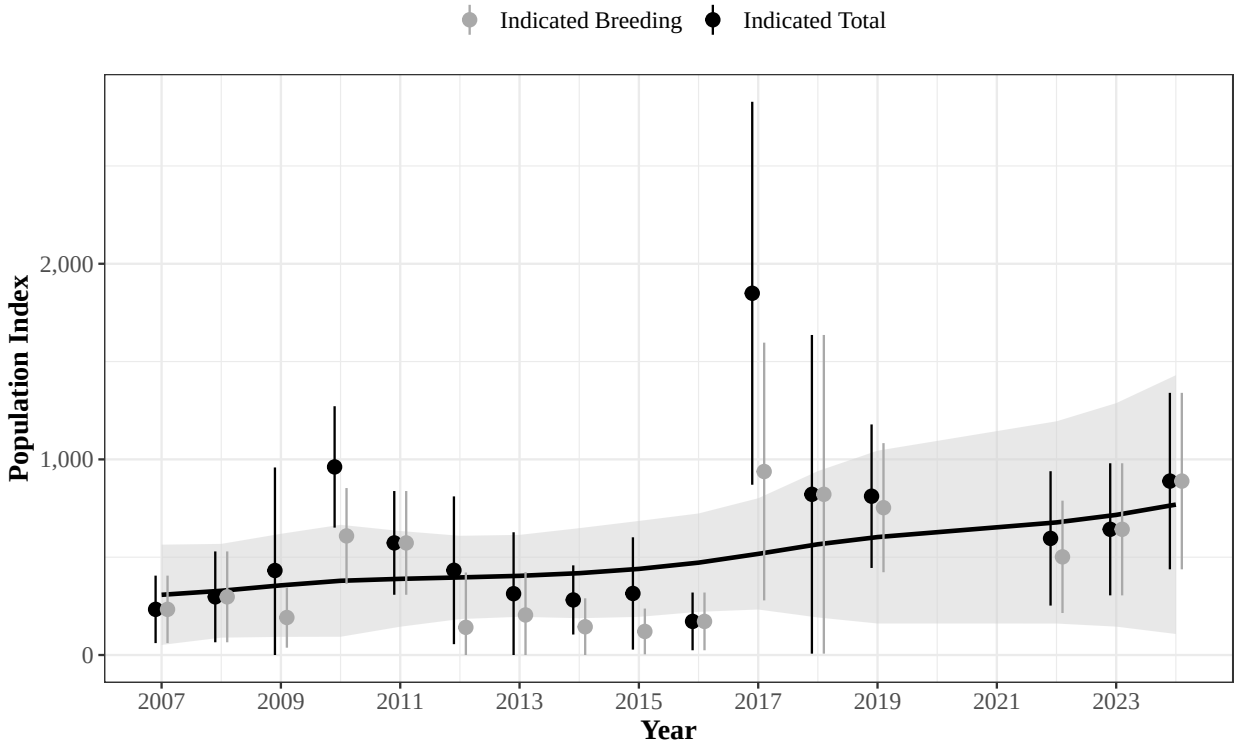

Figure 46: Sandhill crane indices of indicated breeding birds (grey circles; 2 x [singles + pairs]) and indicated total birds (black circles; 2 x [singles + pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in indicated total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Sandhill Crane

Table 24: Sandhill crane indices of indicated breeding birds (2 x [singles + pairs]) and indicated total birds (2 x [singles + pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

	Indicated		Indicated	
Year	**Breeding Birds**	**SE**	**Total Birds**	**SE**
2007	233	88	233	88
2008	297	118	297	118
2009	192	79	432	269
2010	609	125	962	158
2011	573	135	573	135
2012	142	143	433	193
2013	205	112	314	160
2014	144	74	282	90
2015	121	60	315	146
2016	172	75	172	75
2017	938	336	1,849	499
2018	821	416	821	416
2019	753	168	812	187
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	502	146	596	175
2023	643	172	643	172
2024	889	230	889	230

Sandhill Crane

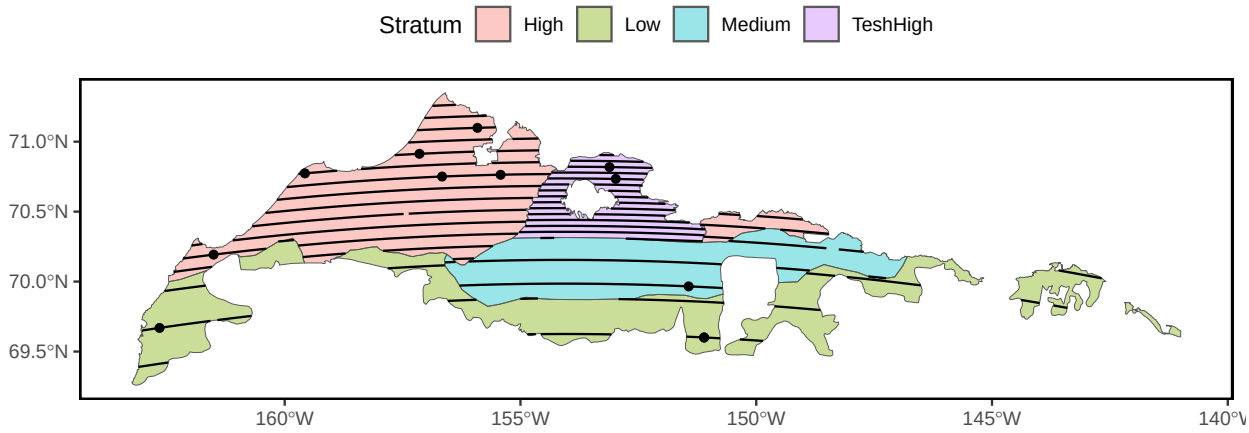

Figure 47: Observations of sandhill cranes along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Jaeger species

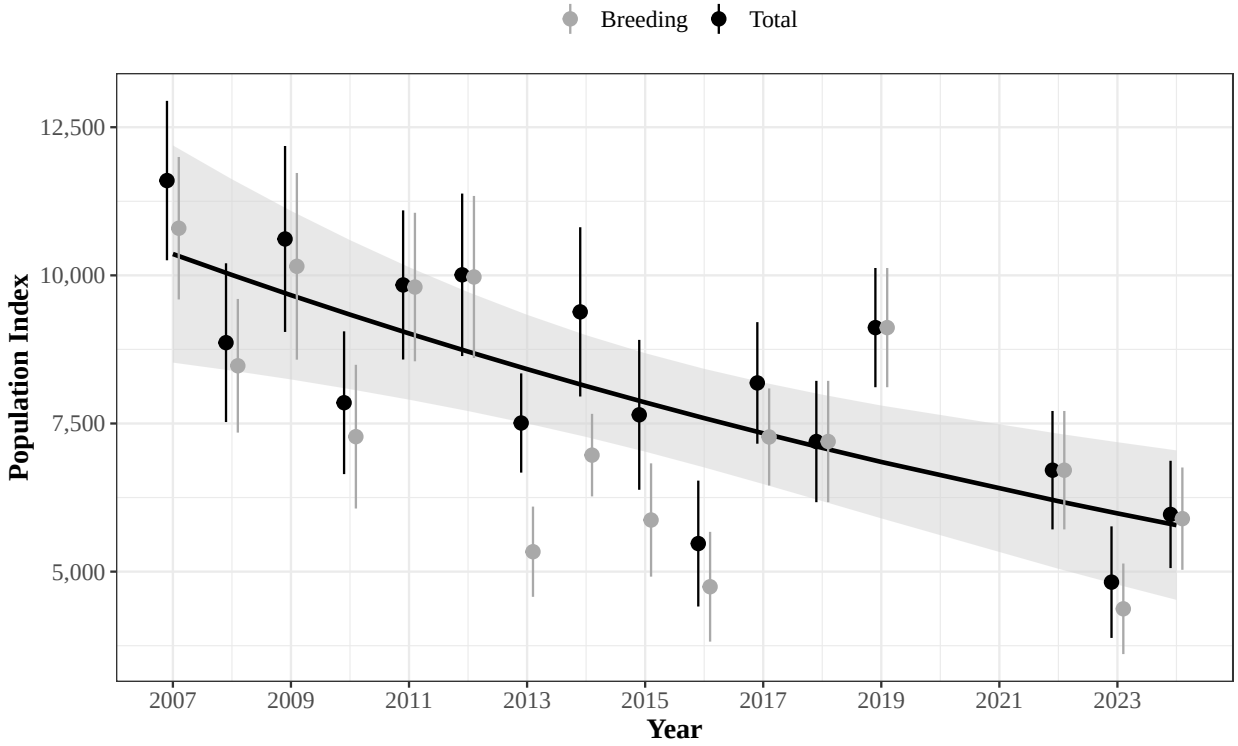

Figure 48: Jaeger species indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Jaeger species

Table 25: Jaeger species indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	10,795	613	11,599	686
2008	8,474	575	8,864	683
2009	10,152	804	10,614	801
2010	7,278	619	7,851	615
2011	9,803	639	9,838	642
2012	9,973	698	10,009	700
2013	5,336	388	7,508	427
2014	6,966	355	9,384	729
2015	5,871	488	7,646	645
2016	4,745	472	5,474	542
2017	7,273	418	8,185	523
2018	7,196	522	7,196	522
2019	9,118	513	9,118	513
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	6,712	510	6,712	510
2023	4,373	390	4,823	480
2024	5,894	440	5,965	462

Jaeger species

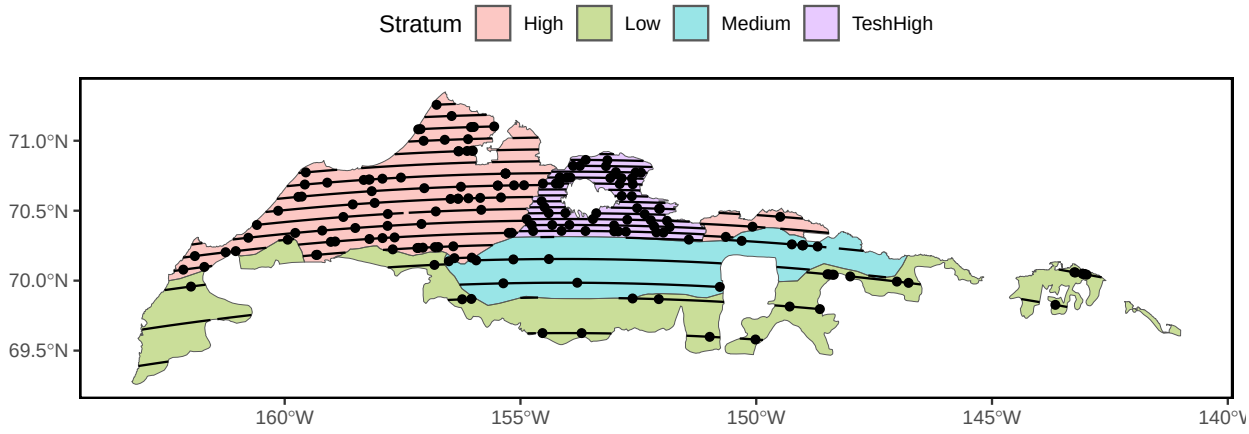

Figure 49: Observations of jaeger species along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Sabine's Gull

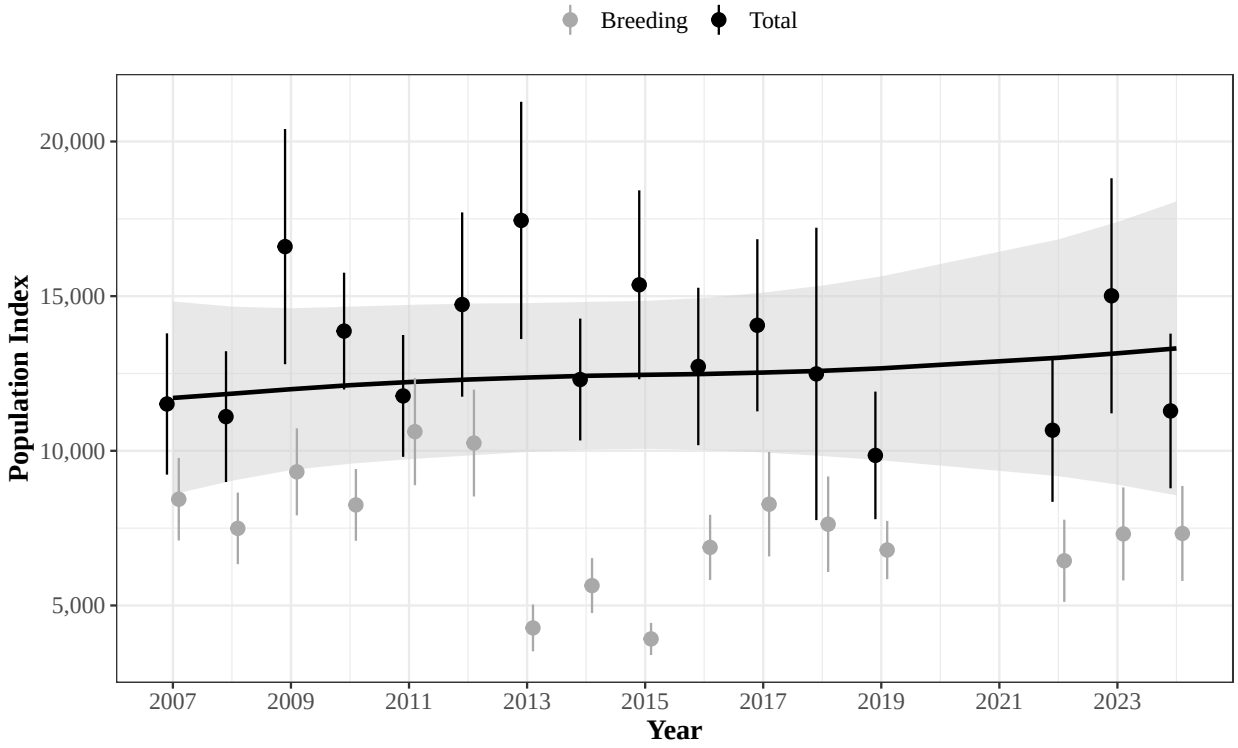

Figure 50: Sabine's gull indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Sabine's Gull

Table 26: Sabine's gull indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	8,434	681	11,514	1,165
2008	7,493	590	11,105	1,079
2009	9,319	718	16,602	1,940
2010	8,251	592	13,871	963
2011	10,619	883	11,775	1,005
2012	10,250	881	14,729	1,520
2013	4,274	386	17,449	1,957
2014	5,642	453	12,305	1,005
2015	3,918	265	15,367	1,558
2016	6,878	537	12,727	1,299
2017	8,274	862	14,058	1,420
2018	7,627	787	12,486	2,411
2019	6,793	480	9,852	1,052
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	6,444	678	10,666	1,182
2023	7,313	768	15,012	1,939
2024	7,328	783	11,288	1,276

Sabine's Gull

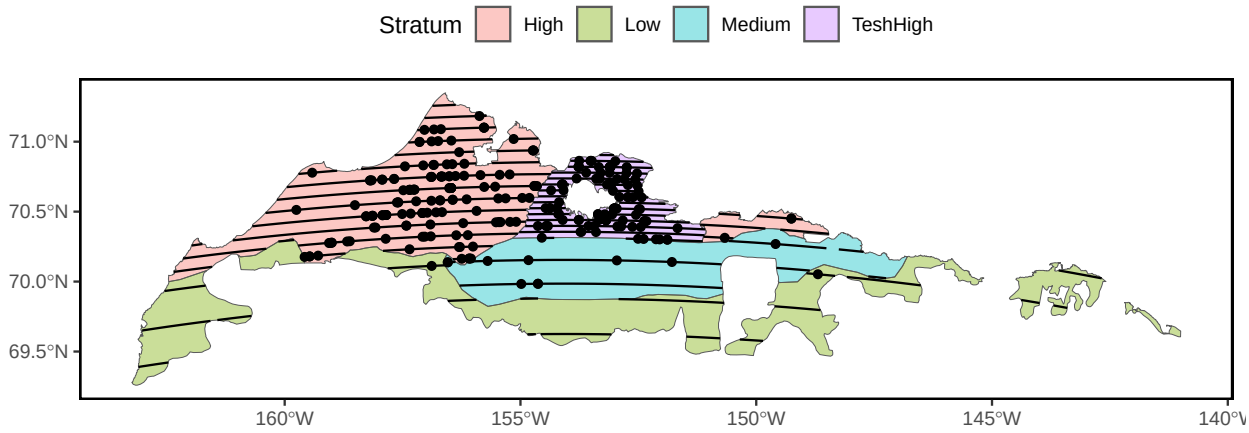

Figure 51: Observations of Sabine's gulls along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Glaucous Gull

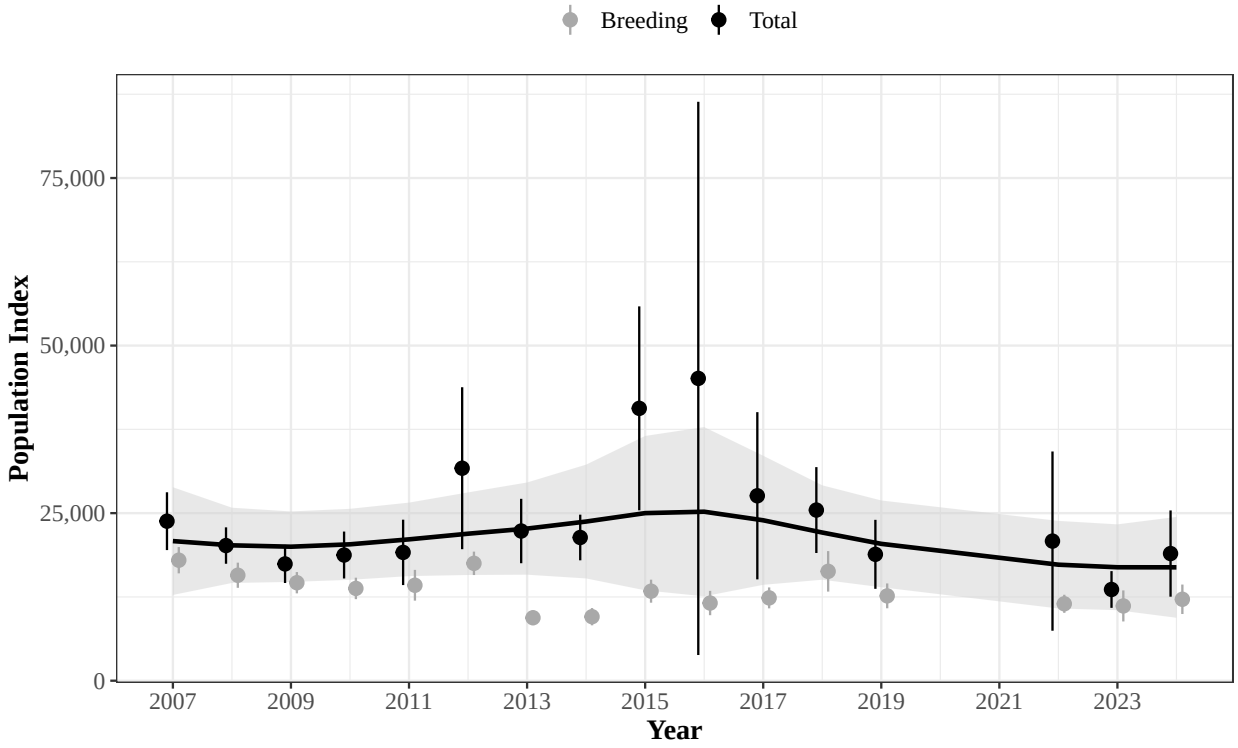

Figure 52: Glaucous gull indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Glaucous Gull

Table 27: Glaucous gull indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	17,979	1,001	23,800	2,201
2008	15,737	958	20,164	1,386
2009	14,619	810	17,422	1,451
2010	13,769	817	18,752	1,787
2011	14,240	1,170	19,145	2,489
2012	17,511	891	31,702	6,164
2013	9,393	558	22,331	2,451
2014	9,550	656	21,369	1,738
2015	13,356	875	40,635	7,762
2016	11,589	926	45,103	21,056
2017	12,355	796	27,591	6,364
2018	16,315	1,541	25,460	3,268
2019	12,658	945	18,855	2,626
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	11,475	688	20,829	6,823
2023	11,156	1,182	13,609	1,397
2024	12,149	1,121	18,969	3,282

Glaucous Gull

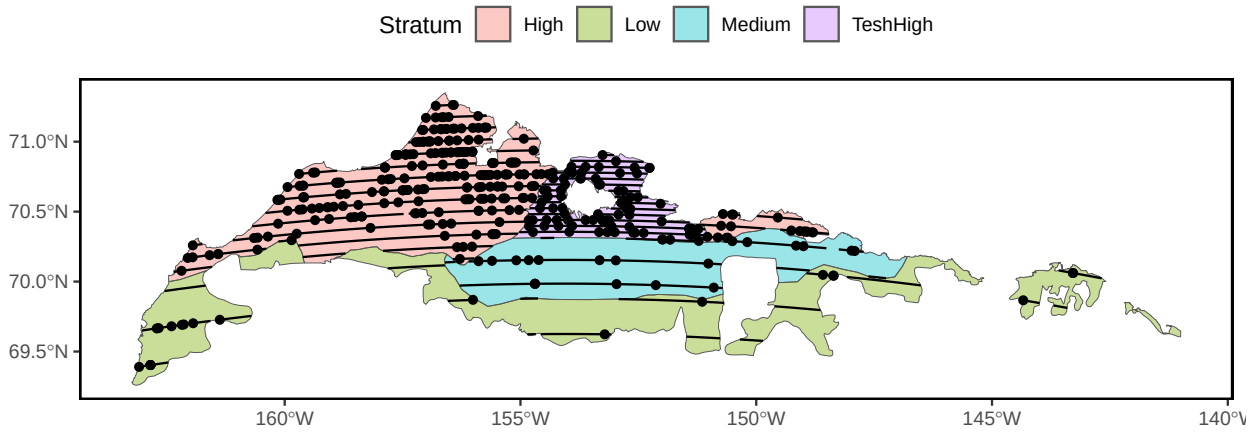

Figure 53: Observations of glaucous gulls along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Arctic Tern

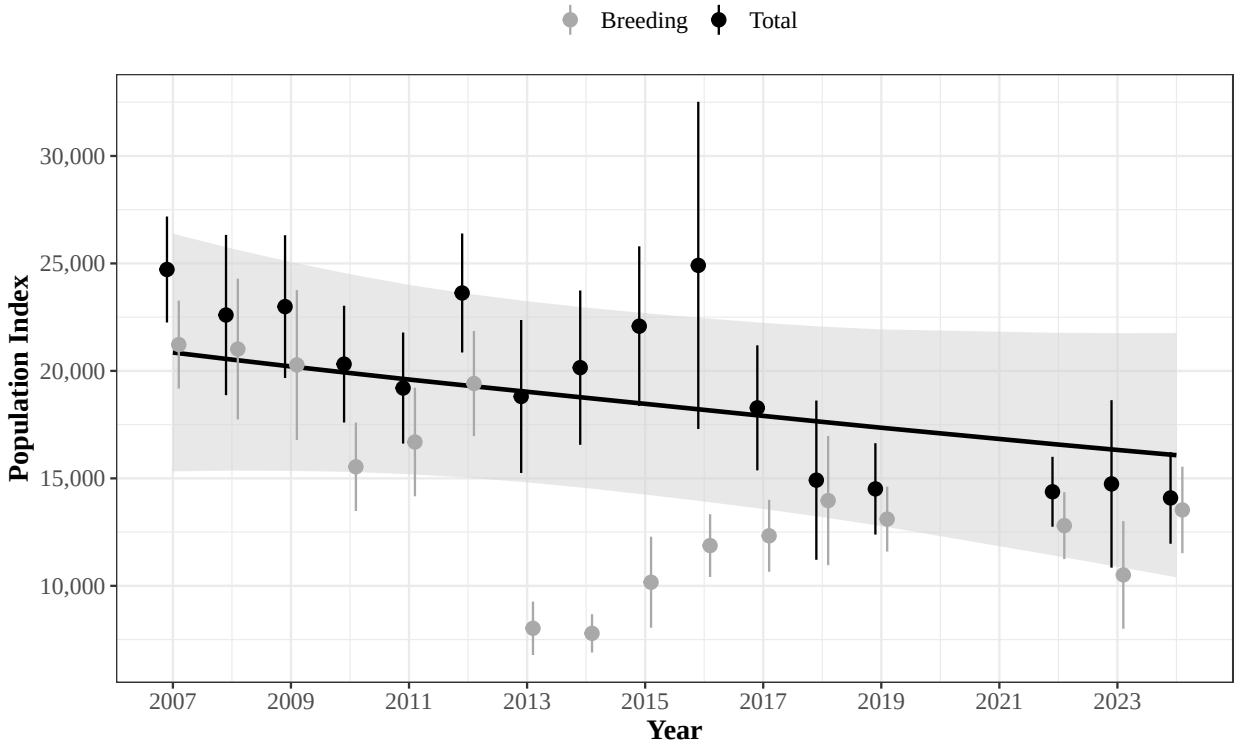

Figure 54: Arctic tern indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Arctic Tern

Table 28: Arctic tern indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	21,223	1,044	24,718	1,258
2008	21,015	1,671	22,600	1,902
2009	20,276	1,779	22,991	1,694
2010	15,538	1,050	20,316	1,385
2011	16,692	1,289	19,202	1,318
2012	19,412	1,248	23,625	1,412
2013	8,025	634	18,810	1,815
2014	7,789	455	20,151	1,831
2015	10,167	1,081	22,081	1,895
2016	11,873	745	24,909	3,883
2017	12,328	854	18,281	1,484
2018	13,967	1,533	14,917	1,890
2019	13,105	771	14,510	1,084
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	12,802	793	14,377	829
2023	10,507	1,278	14,743	1,987
2024	13,532	1,025	14,090	1,087

Arctic Tern

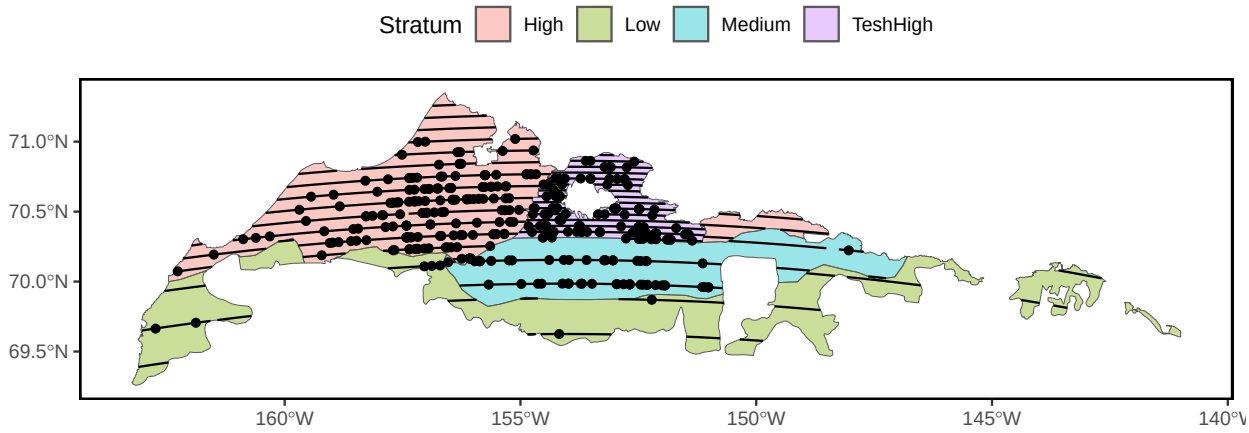

Figure 55: Observations of Arctic terns along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Red-throated Loon

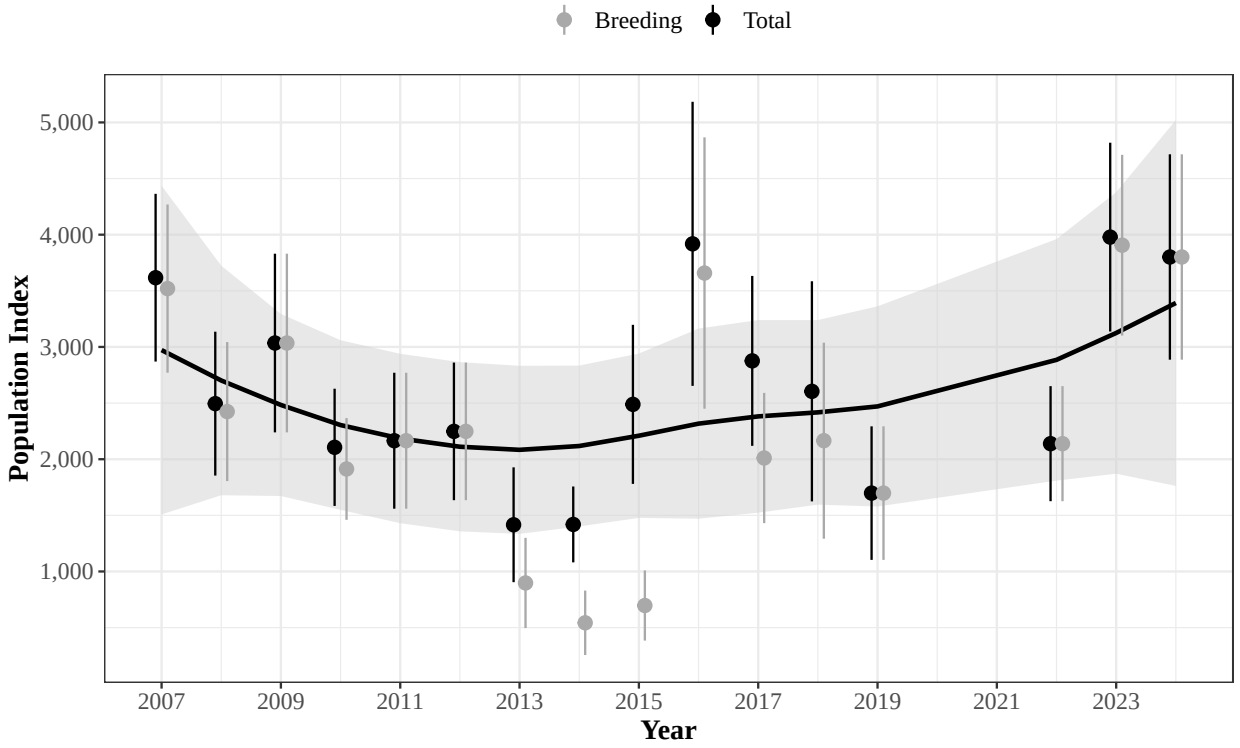

Figure 56: Red-throated loon indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Red-throated Loon

Table 29: Red-throated loon indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	3,520	382	3,617	381
2008	2,424	316	2,495	327
2009	3,035	406	3,035	406
2010	1,913	231	2,106	266
2011	2,165	309	2,165	309
2012	2,248	313	2,248	313
2013	898	205	1,416	261
2014	543	146	1,419	172
2015	697	159	2,489	361
2016	3,658	617	3,918	646
2017	2,011	296	2,876	386
2018	2,165	445	2,605	500
2019	1,698	303	1,698	303
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	2,138	261	2,138	261
2023	3,906	411	3,978	429
2024	3,801	467	3,801	467

Red-throated Loon

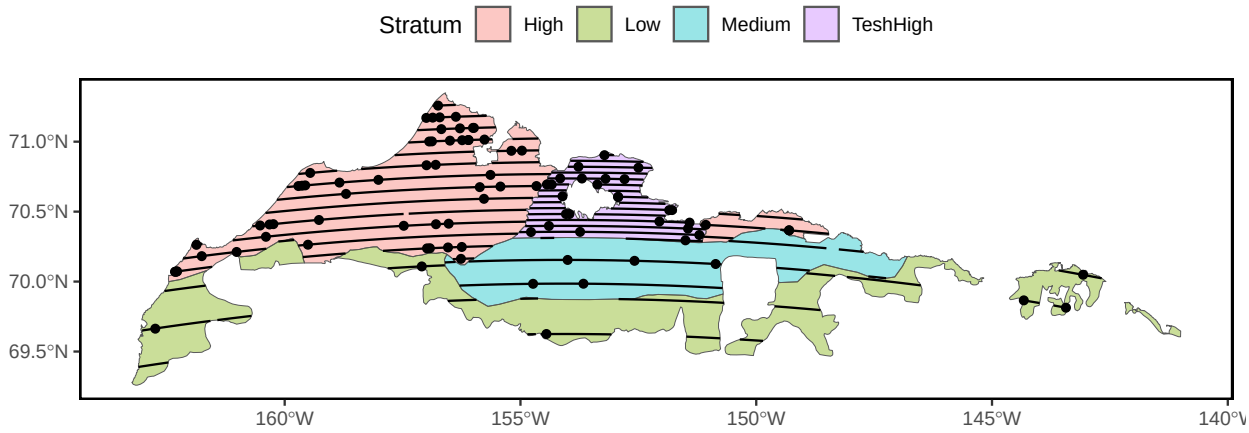

Figure 57: Observations of red-throated loons along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Pacific Loon

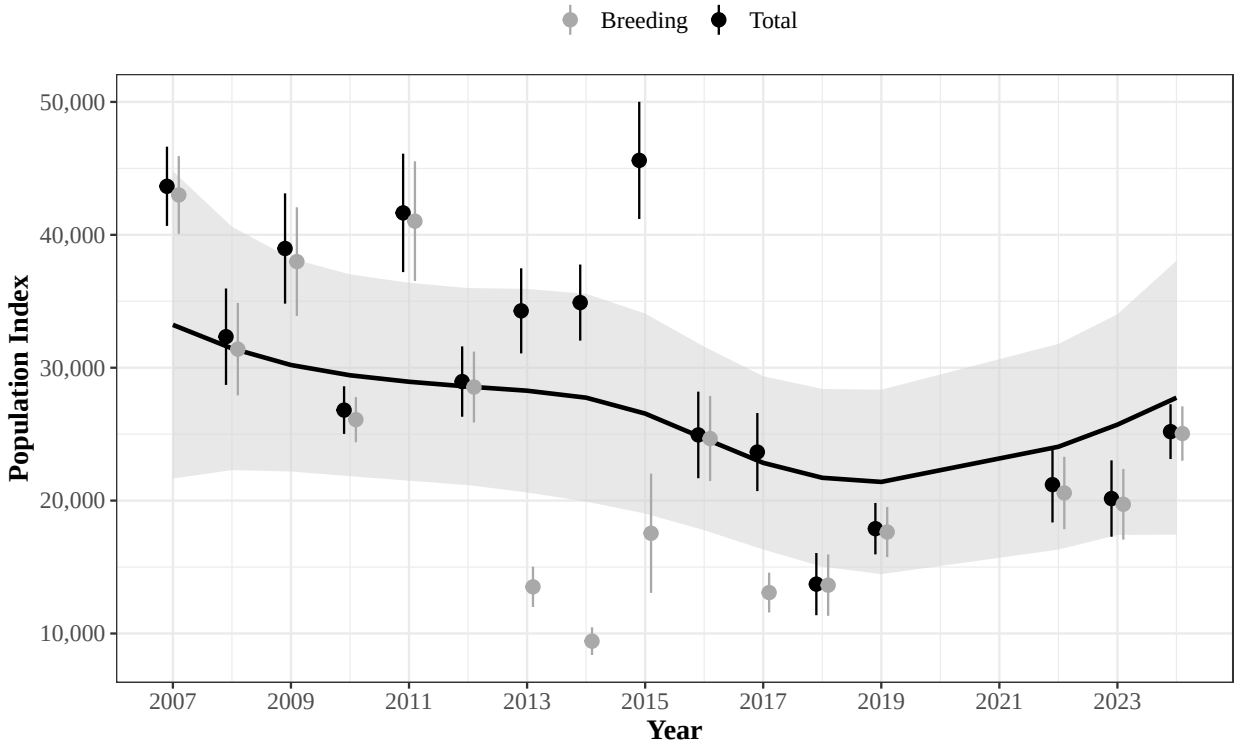

Figure 58: Pacific loon indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Pacific Loon

Table 30: Pacific loon indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	42,999	1,491	43,653	1,521
2008	31,397	1,775	32,335	1,851
2009	37,985	2,086	38,972	2,117
2010	26,093	867	26,811	914
2011	41,029	2,296	41,651	2,273
2012	28,545	1,360	28,957	1,351
2013	13,511	775	34,279	1,634
2014	9,422	532	34,902	1,461
2015	17,542	2,289	45,602	2,250
2016	24,671	1,634	24,942	1,662
2017	13,081	766	23,653	1,499
2018	13,637	1,178	13,715	1,194
2019	17,634	961	17,888	987
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	20,574	1,390	21,202	1,452
2023	19,721	1,356	20,153	1,466
2024	25,046	1,044	25,189	1,051

Pacific Loon

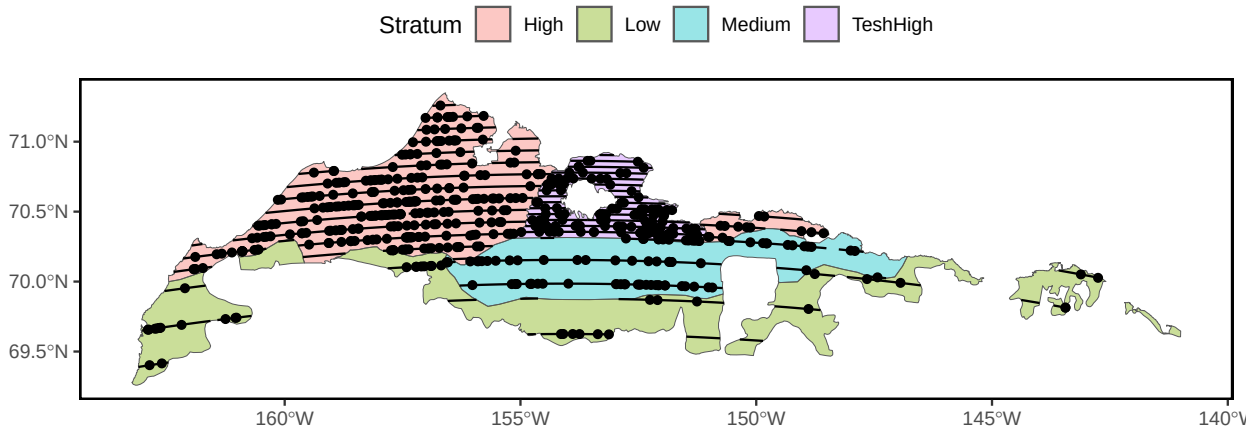

Figure 59: Observations of Pacific loons along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Yellow-billed Loon

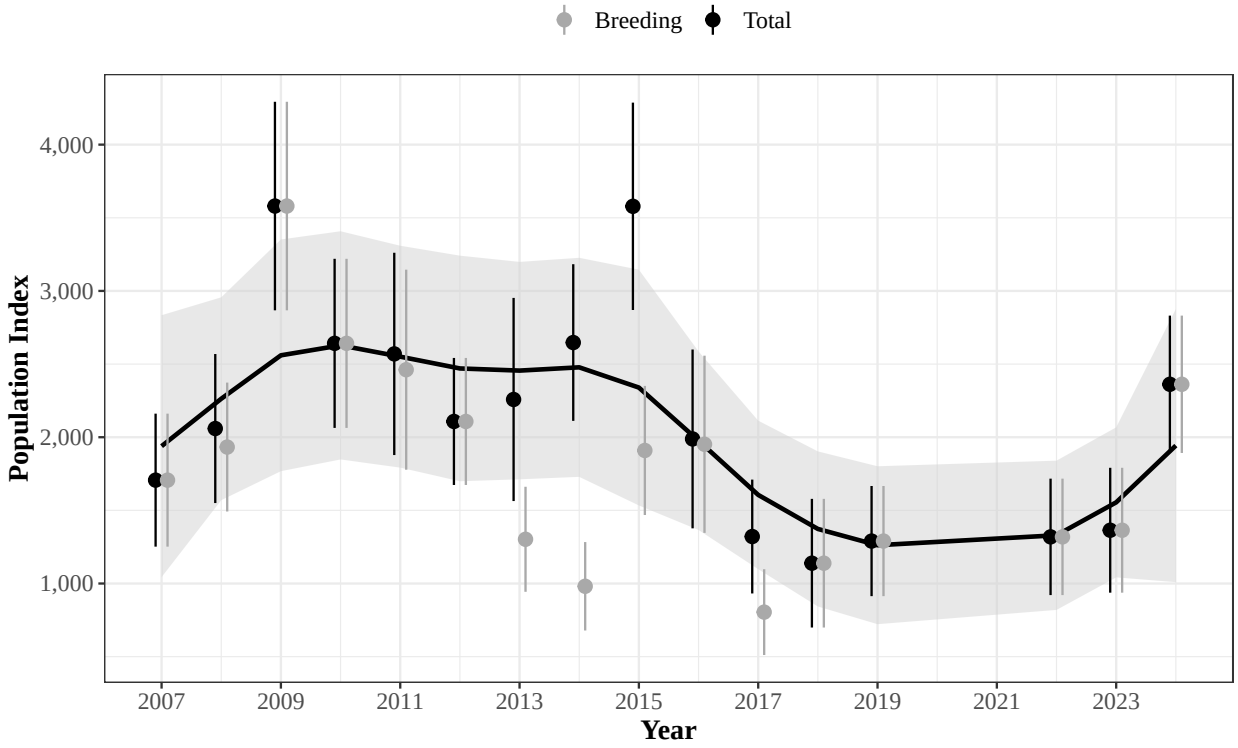

Figure 60: Yellow-billed loon indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Yellow-billed Loon

Table 31: Yellow-billed loon indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	1,707	232	1,707	232
2008	1,933	225	2,059	260
2009	3,580	364	3,580	364
2010	2,642	295	2,642	295
2011	2,462	349	2,570	353
2012	2,108	222	2,108	222
2013	1,302	183	2,258	354
2014	981	154	2,647	273
2015	1,909	225	3,578	362
2016	1,952	309	1,988	312
2017	804	150	1,321	199
2018	1,139	224	1,139	224
2019	1,290	192	1,290	192
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	1,319	203	1,319	203
2023	1,364	218	1,364	218
2024	2,362	240	2,362	240

Yellow-billed Loon

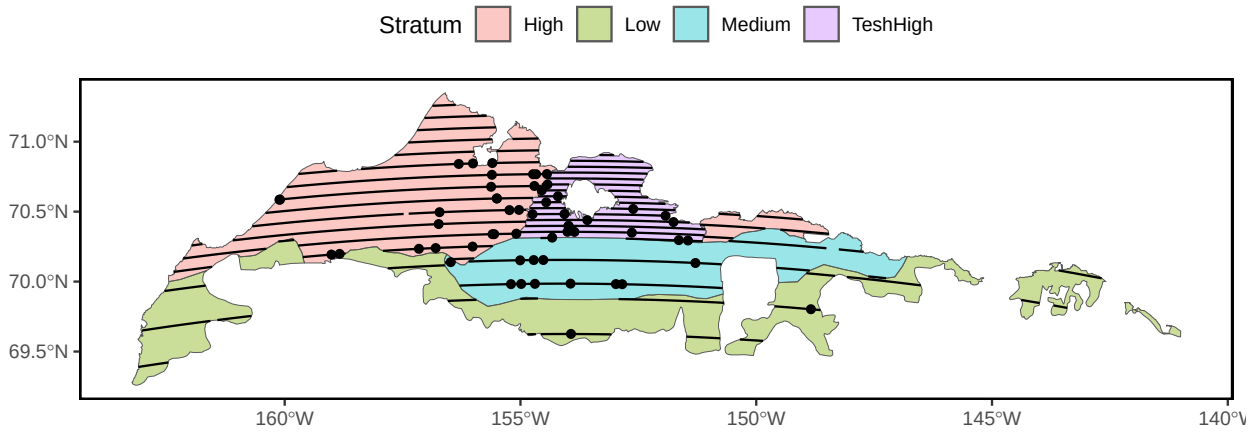

Figure 61: Observations of yellow-billed loons along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Golden Eagle

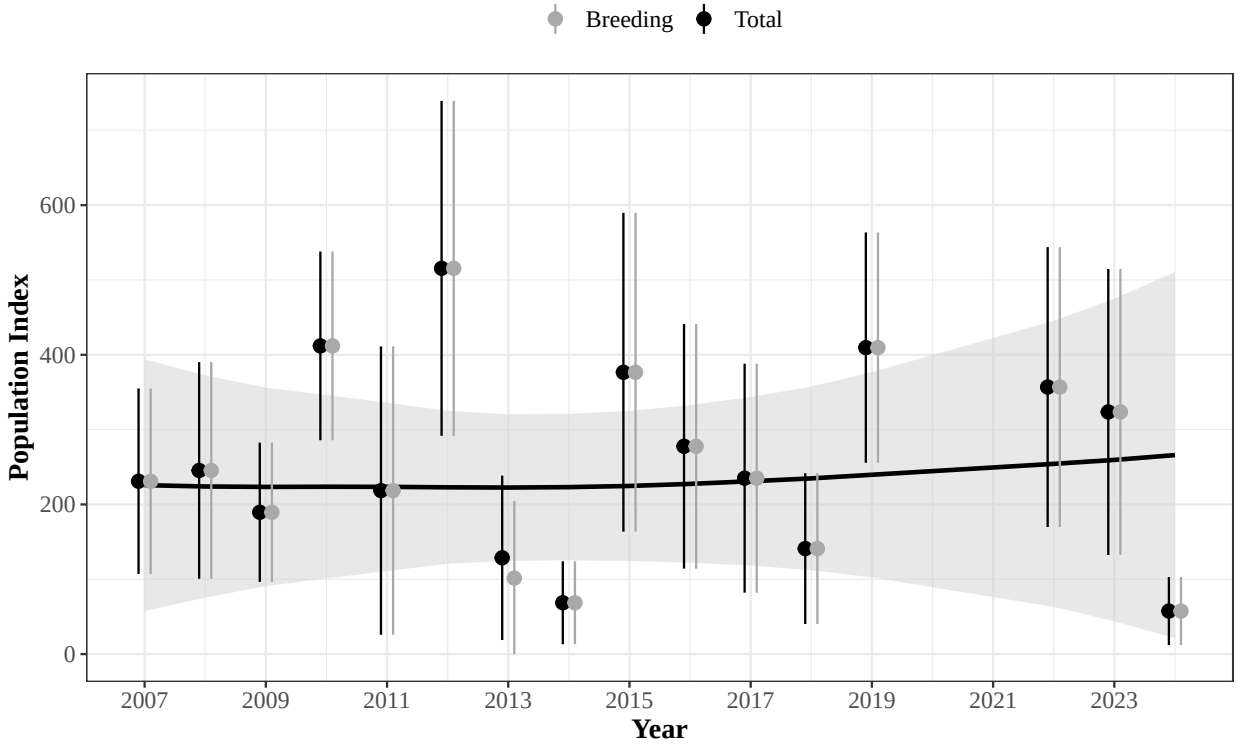

Figure 62: Golden eagle indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Golden Eagle

Table 32: Golden eagle indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	231	63	231	63
2008	245	74	245	74
2009	190	47	190	47
2010	412	64	412	64
2011	218	98	218	98
2012	516	114	516	114
2013	101	53	129	56
2014	69	28	69	28
2015	377	109	377	109
2016	278	83	278	83
2017	235	78	235	78
2018	141	51	141	51
2019	410	79	410	79
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	357	95	357	95
2023	324	97	324	97
2024	58	23	58	23

Golden Eagle

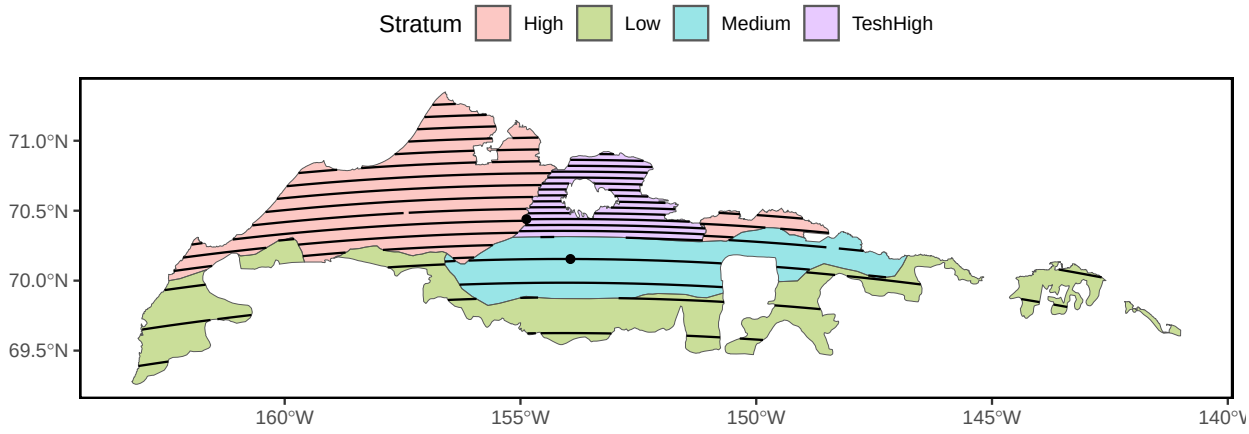

Figure 63: Observations of golden eagles along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Short-eared Owl

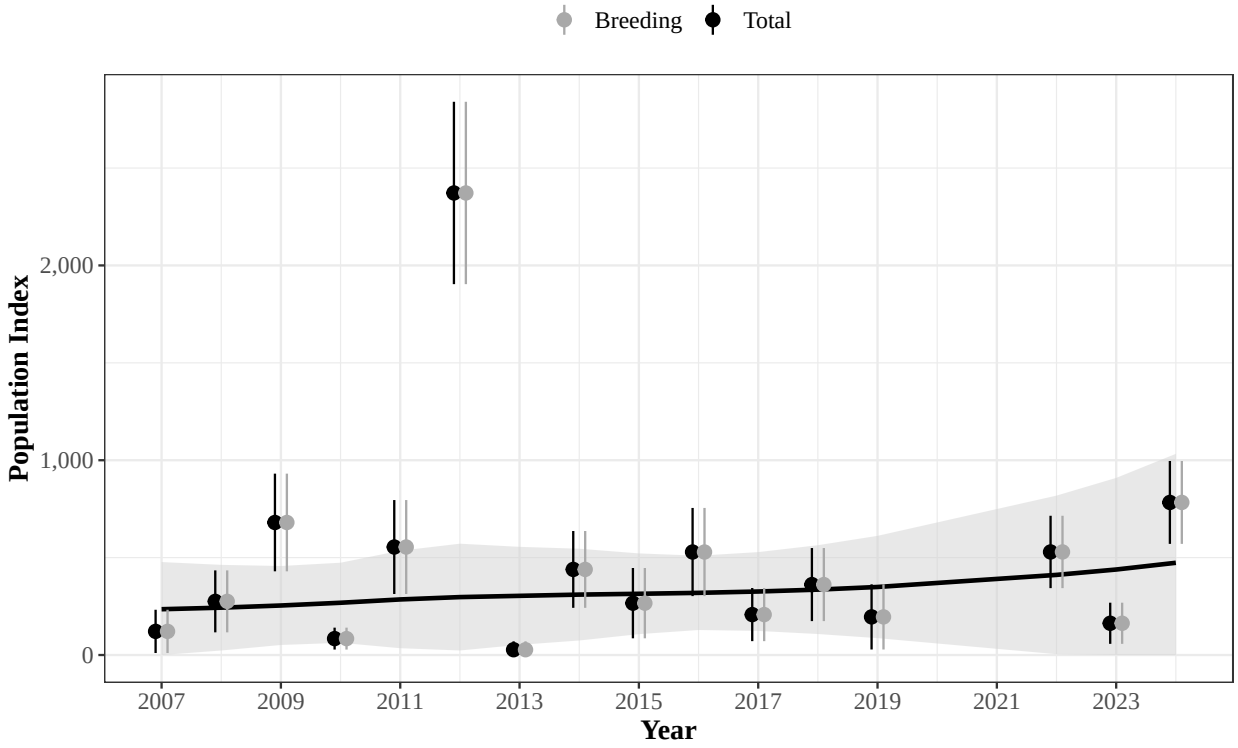

Figure 64: Short-eared owl indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Short-eared Owl

Table 33: Short-eared owl indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	121	57	121	57
2008	275	81	275	81
2009	680	128	680	128
2010	84	29	84	29
2011	554	123	554	123
2012	2,372	239	2,372	239
2013	27	22	27	22
2014	439	101	439	101
2015	266	92	266	92
2016	529	115	529	115
2017	208	70	208	70
2018	362	96	362	96
2019	196	85	196	85
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	529	95	529	95
2023	163	54	163	54
2024	783	109	783	109

Short-eared Owl

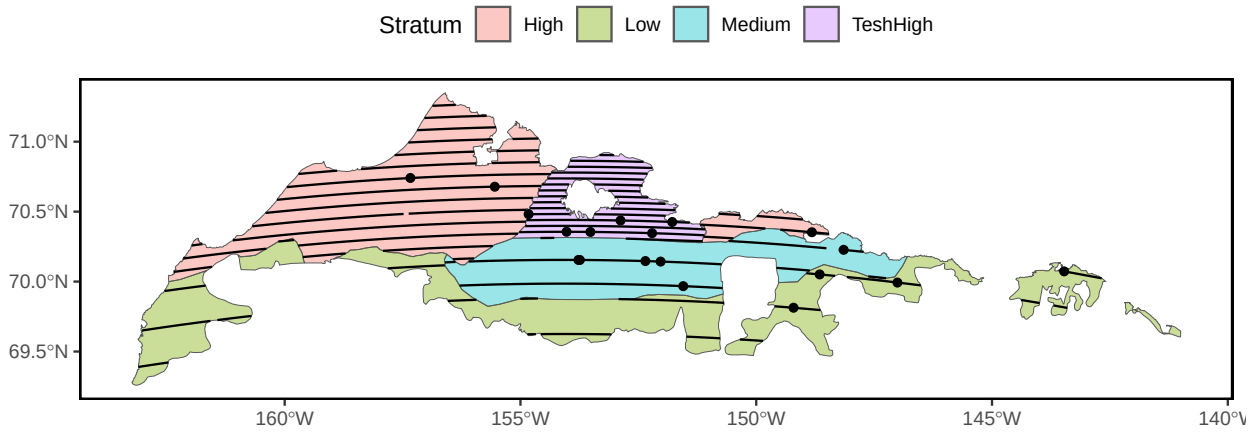

Figure 65: Observations of short-eared owls along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Snowy Owl

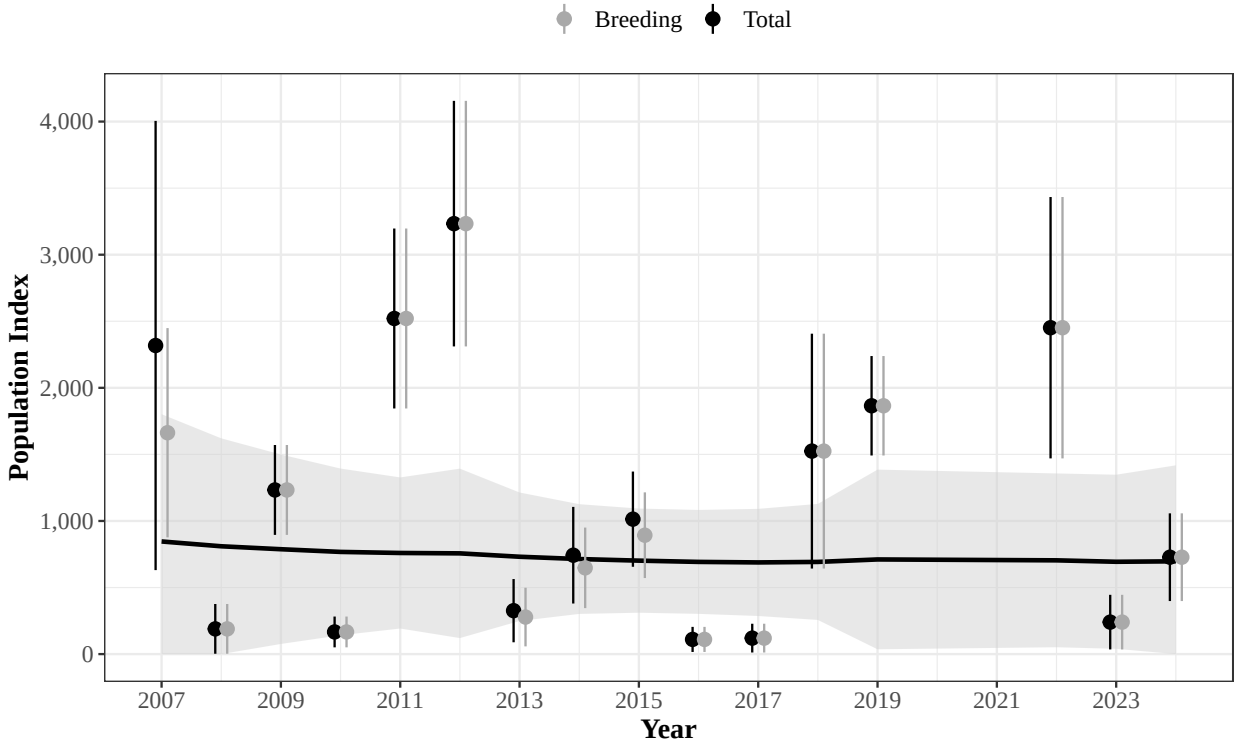

Figure 66: Snowy owl indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Snowy Owl

Table 34: Snowy owl indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	1,663	401	2,318	861
2008	189	95	189	95
2009	1,233	172	1,233	172
2010	166	59	166	59
2011	2,521	345	2,521	345
2012	3,233	471	3,233	471
2013	278	112	326	121
2014	648	154	743	185
2015	893	164	1,014	182
2016	110	48	110	48
2017	120	55	120	55
2018	1,525	450	1,525	450
2019	1,865	191	1,865	191
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	2,452	501	2,452	501
2023	240	105	240	105
2024	728	168	728	168

Snowy Owl

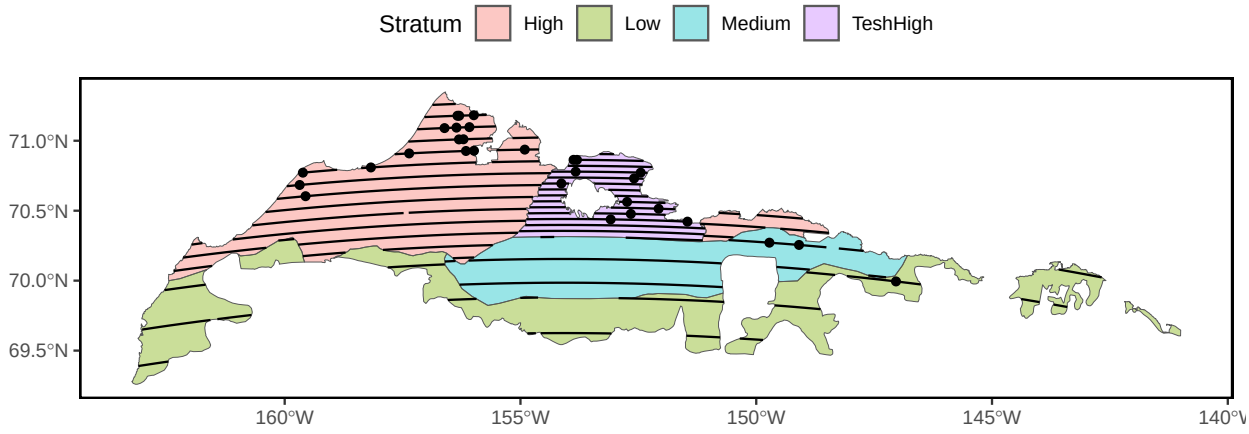

Figure 67: Observations of snowy owls along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).

Common Raven

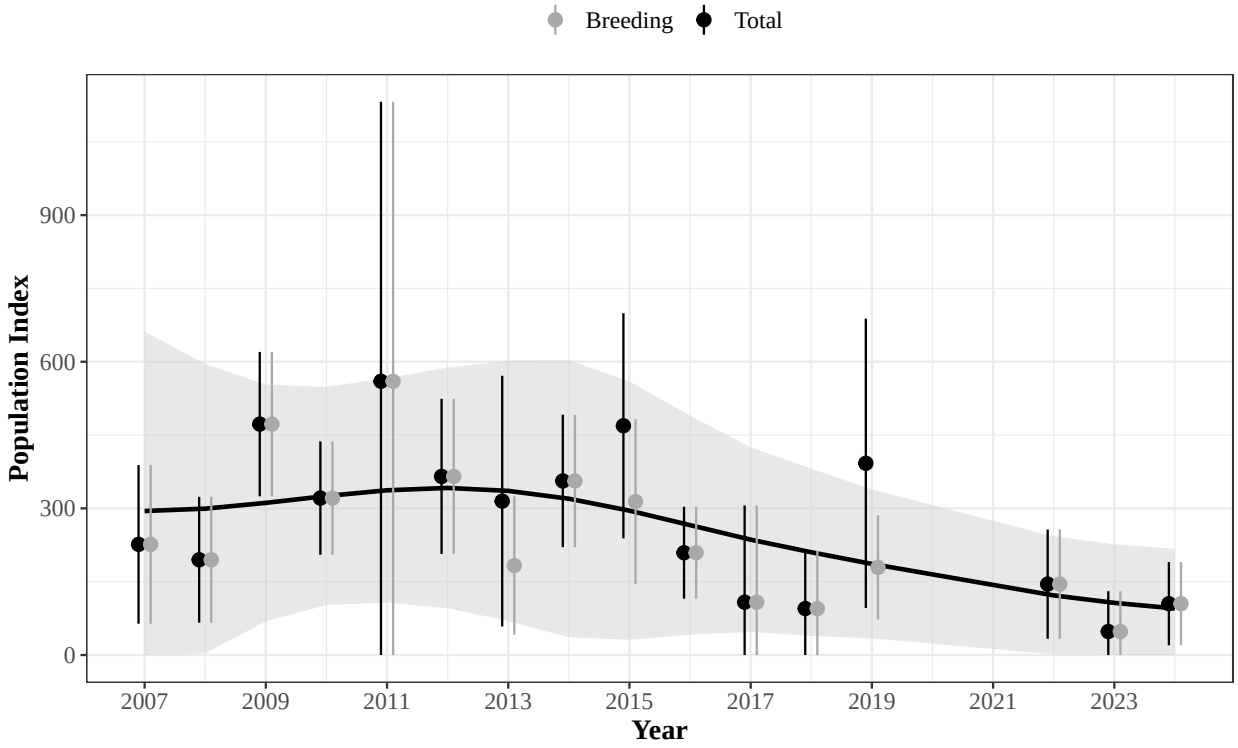

Figure 68: Common raven indices of breeding birds (grey circles; singles + [2 x pairs]) and total birds (black circles; singles + [2 x pairs] + birds in flocks) with 95% confidence intervals (vertical bars from circles), as well as the long-term trend in total birds (black line; 2007–2024) and associated 95% credible intervals (grey band around line) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007–2024. Years with counts of zero were not included in trend estimates (see Methods for details).

Common Raven

Table 35: Common raven indices of breeding birds (singles + [2 x pairs]) and total birds (singles + [2 x pairs] + birds in flocks) with standard errors (SE) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, 2007-2024.

Year	Breeding Birds	SE	Total Birds	SE
2007	226	83	226	83
2008	195	66	195	66
2009	472	75	472	75
2010	321	59	321	59
2011	560	292	560	292
2012	365	81	365	81
2013	183	72	315	131
2014	356	69	356	69
2015	314	86	469	118
2016	209	48	209	48
2017	108	101	108	101
2018	95	60	95	60
2019	179	54	392	151
2020	NA	NA	NA	NA
2021	NA	NA	NA	NA
2022	145	57	145	57
2023	48	42	48	42
2024	105	43	105	43

Common Raven

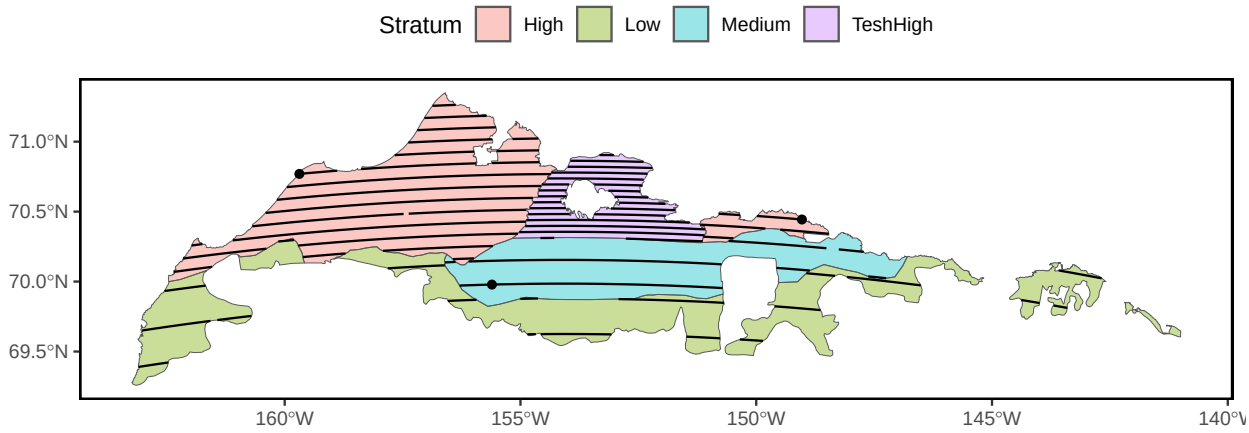

Figure 69: Observations of common ravens along transects within four physiographic-based strata (high, medium, low, and Teshekpuk high) from the Arctic Coastal Plain Aerial Breeding Population Survey, Alaska, during the most recent survey year (2024).