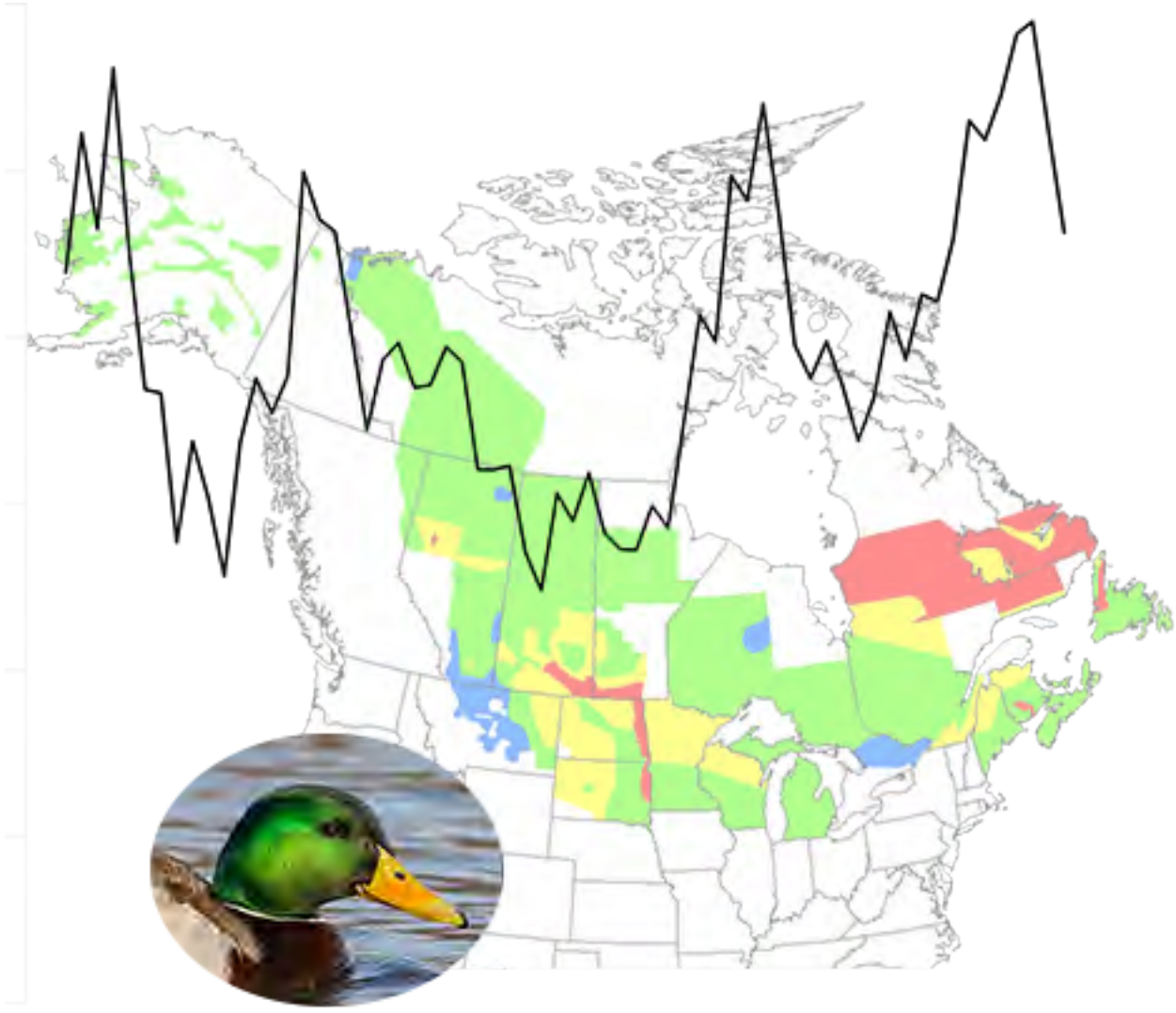
U.S. Fish & Wildlife Service

Waterfowl

Population Status, 2018



Waterfowl Population Status, 2018

August 20, 2018

In the United States the process of establishing hunting regulations for waterfowl is conducted annually. This process involves a number of scheduled meetings in which information regarding the status of waterfowl is presented to individuals within the agencies responsible for setting hunting regulations. In addition, the proposed regulations are published in the Federal Register to allow public comment. This report includes the most current breeding population and production information available for waterfowl in North America and is a result of cooperative efforts by the U.S. Fish and Wildlife Service (USFWS), the Canadian Wildlife Service (CWS), various state and provincial conservation agencies, and private conservation organizations. In addition to providing current information on the status of populations, this report is intended to aid the development of waterfowl harvest regulations in the United States for the 2019–2020 hunting season.

Acknowledgments

Waterfowl Population and Habitat Information: The information contained in this report is the result of the efforts of numerous individuals and organizations. Principal contributors include the Canadian Wildlife Service, U.S. Fish and Wildlife Service, state wildlife conservation agencies, provincial conservation agencies from Canada, and Dirección General de Conservación Ecológica de los Recursos Naturales, Mexico. In addition, several conservation organizations, other state and federal agencies, universities, and private individuals provided information or cooperated in survey activities. Appendix A.1 provides a list of individuals responsible for the collection and compilation of data for the "Status of Ducks" section of this report. Appendix A.2 provides a list of individuals who were primary contacts for information included in the "Status of Geese and Swans" section. We apologize for any omission of individuals from these lists, and thank all participants for their contributions. Without this combined effort, a comprehensive assessment of waterfowl populations and habitat would not be possible.

This report was compiled by the U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Assessment and Decision Support, Monitoring and Data Management, and Migratory Bird Surveys branches. The principal authors are Joshua Dooley, Walt Rhodes, and Nathan Zimpfer. The preparation of this report involved substantial efforts on the part of many individuals. Support for the processing of data and publication was provided by Emily Silverman, Guthrie Zimmerman, and John Sauer. Pamela Garrettson, James Dubovsky, Rebecca Rau and others provided helpful comments on earlier drafts. Kathy Fleming and Phil Thorpe provided the maps.

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All Division of Migratory Bird Management reports are available from our website (https://www.fws.gov/birds/surveys-and-data/reports-and-publications.php).

Executive Summary

This report summarizes the most recent information about the status of North American waterfowl populations and their habitats to facilitate the development of harvest regulations. The annual status of these populations is monitored and assessed through abundance and harvest surveys. This report details abundance estimates; harvest survey results are discussed in separate reports. The data and analyses were those most currently available when this report was written. Future analyses may yield slightly different results as databases are updated and new analytical procedures become available.

In general, habitat conditions during the 2018 WBPHS were similar to or declined, with a few exceptions, relative to 2017. Much of the Canadian prairies experienced average fall and winter precipitation and below-average spring precipitation. Fall and winter temperatures were mainly average. However, well-below-average temperatures were recorded February–April 2018 and were well-above average in May 2018. The U.S. prairies experienced average-to-above-average precipitation but had more variable conditions compared to prairie Canada. Habitat conditions generally declined northward, particularly near the Montana–North Dakota border with Canada. The total pond estimate (Prairie Canada and northcentral U.S. combined) was 5.2 ± 0.2 million, which was 14% below the 2017 estimate of 6.1 ± 0.2 million and similar to the long-term average of 5.2 ± 0.03 million. The 2018 estimate of ponds in Prairie Canada was 3.7 ± 0.1 million. This estimate was 15% below the 2017 estimate of 4.3 ± 0.2 million and similar to the long-term average (3.5 ± 0.02 million). The 2018 pond estimate for the northcentral U.S. was 1.6 ± 0.09 million, which was similar to the 2017 estimate (1.8 ± 0.09 million) and the long-term average (1.7 ± 0.01 million). Spring phenology and timing of ice-out was near normal but slightly delayed at some places in the traditional survey area. Spring phenology was earlier than average in southwestern Alaska and later than average across most areas in northern Alaska and the western, central, and eastern Arctic and Subarctic. Above-average or average breeding conditions were expected for goose and swan populations in southern Alaska and below-average or average breeding conditions were expected for most other areas. The boreal forest experienced generally average precipitation and temperatures, similar to the Canadian prairies. Habitat quality generally declined across the survey area compared to last year, with the exception of southern Alberta and eastern Montana which improved. Overall, habitat quality remains good over a large portion of the region and should lead to average waterfowl production this year.

Conditions in much of the eastern survey area declined or remained similar relative to 2017. The region experienced mainly average precipitation since September 2017 and variable fall and winter temperatures. The entire region had well-below-average temperatures in April 2018 that continued into May in more northerly areas. Spring phenology and ice-out were generally normal or much later than normal, the latter mainly in northern Quebec and Labrador. Conditions for waterfowl production generally declined to fair or good, with northern areas affected by a late thaw and localized flooding farther south.

Summary of Duck Populations

In the traditional survey area, which includes strata 1-18, 20-50, and 75-77, the total duck population estimate (excluding scoters [*Melanitta* spp.], eiders [*Somateria* spp., and *Polysticta* spp.], long-tailed ducks [*Clangula hymenalis*], mergansers [*Mergus* spp. and *Lephodytes cucullatus*], and wood ducks [*Aix sponsa*]) was 41.2 ± 0.7 million birds. This estimate was 13% lower than the 2017 estimate

of 47.3 ± 0.8 million and 17% higher than the long-term average (1955–2017). Estimated mallard (*Anas platyrhynchos*) abundance was 9.3 ± 0.3 million, which was 12% lower than the 2017 estimate of 10.5 ± 0.3 million but 17% above the long-term average of 7.9 ± 0.04 million. The 2018 estimate for blue-winged teal (*Spatula discors*; 6.4 ± 0.3 million) was 18% below the 2017 estimate and 27% above the long-term average of 5.1 ± 0.04 million. Estimated abundance of gadwall (*Anas strepera*; 2.9 ± 0.2 million) was 31% below 2017 but 43% above the long-term average. The 2018 northern shoveler (*Spatula clypeata*) estimate was similar to last year and 62% above the long-term average of 2.6 ± 0.02 million. The estimated abundance of green-winged teal (*Anas crecca*) was 3.0 ± 0.2 million, which was 16% below the 2017 estimate of 3.6 ± 0.2 million and 42% above the long-term average (2.1 ± 0.02 million). Estimated abundance of redheads (*Aythya americana*; 1.0 ± 0.09 million) was similar to the 2017 estimate but 38% above the long-term average of 0.7 ± 0.01 million. Northern pintail (*Anas acuta*) abundance (2.4 ± 0.2 million) was 18% below the 2017 estimate and 40% below the long-term average of 4.0 ± 0.03 million. Abundance estimates for American wigeon (*A. americana*; 2.8 ± 0.2 million) and canvasbacks (*Aythya valisineria*; 0.7 ± 0.06 million) were similar to their 2017 estimates and their long-term averages of 2.6 ± 0.02 million and 0.6 ± 0.01 million, respectively. The combined estimate of lesser and greater scaup (*A. affinis* and *A. marila*; 4.0 ± 0.2 million) was similar to the 2017 estimate and 20% below the long-term average of 5.0 ± 0.04 million.

In the eastern survey area, the estimated abundance of mallards was 1.1 ± 0.12 million, which was similar to the 2017 estimate but 15% below the long-term average. The estimate of goldeneyes (*Bucephala clangula* and *B. islandica*) was 0.5 ± 0.13 million, which was similar to the 2017 estimate and 17% below the 1998–2017 average. Estimates of green-winged teal (0.3 ± 0.08 million) and mergansers (0.7 ± 0.07 million) were similar to their 2017 estimates and 1998–2017 averages. Ring-necked ducks (*A. collaris*; 0.6 ± 0.13 million) were similar to the 2017 estimate and the 1998–2017 average. A time series for assessing changes in American black duck (*Anas rubripes*) population status is provided by the breeding waterfowl surveys conducted by the USFWS and CWS in the eastern survey area. The 2018 estimate of American black ducks in the eastern survey area was 0.7 ± 0.07 million, which was similar to last year's estimate of 0.8 ± 0.09 million but 20% below the 1998–2017 average.

Summary of Goose and Swan Populations

Of the 24 applicable goose and tundra swan (*Cygnus columbianus*) populations included in this year's report with updated estimates, the primary monitoring indices for eight of these populations had significant ($P < 0.05$) positive trends (% change per year) during the most recent 10-year period: Western Prairie and Great Plains Population (+2%), Rocky Mountain Population (+8%), Pacific Population (+4%), and Aleutian (+8%) Canada geese (*Branta* spp.), Wrangel Island Population lesser snow geese (*Chen caerulescens*; +11%), Mid-continent Population white-fronted geese (*Anser albifrons*; +4%), emperor geese (*Chen canagica*; +6%), and Eastern Population tundra swans (+2%). Two populations had a significant negative 10-year trend: Ross's geese (*C. rossii*; −4%) and Pacific brant (*Branta bernicla nigricans*; −3%). Of the 18 populations for which primary indices included variance estimates, the most recent estimate significantly increased from the prior year's estimate for one population and significantly decreased for three populations: Greater snow geese (*Chen caerulescens atlantica*; +17%), Atlantic Population (−30%) and Cackling (−30%) Canada geese, and Ross's geese (−28%). Of the six populations for which primary indices did not include variance estimates, the most recent count was greater than the prior count for one population and was less than the prior count for five populations: Wrangel Island Population lesser snow geese (−12%), Atlantic (+5%) and Pacific (−21%) brant, Pacific (−20%) and Mid-continent (−23%) Population white-fronted geese, and Eastern Population tundra swans (−6%).

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Status of Ducks

This section summarizes the most recent information about the status of North American duck populations and their habitats. The annual status of these populations is assessed using databases resulting from surveys which include estimates of the sizes of breeding populations and harvest. This report details abundance estimates; harvest survey results are discussed in separate reports. The data and analyses were the most current available when this report was written. Future analyses may yield slightly different results as databases are updated and new analytical procedures become available.

Methods

Waterfowl Breeding Population and Habitat Survey (WBPHS)

Federal, provincial, and state agencies conduct surveys each spring to estimate the size of breeding waterfowl populations and to evaluate habitat conditions. These surveys are conducted by ground (Atlantic Flyway Breeding Waterfowl Survey; Sauer et al. 2014) or by airplanes and helicopters, and cover over 2.0 million square miles that encompass principal breeding areas of North America. The traditional survey area (strata 1–18, 20–50, and 75–77) comprises parts of Alaska, Canada, and the northcentral U.S., and covers approximately 1.3 million square miles (Appendix B). Specifics on the survey design are provided in Smith (1995). The eastern survey area (strata 51–53, 56, and 62–72) includes parts of Ontario, Quebec, Labrador, Newfoundland, Nova Scotia, Prince Edward Island, New Brunswick, and Maine, covering an area of approximately 0.7 million square miles (Appendix B). Historically, surveys in the east were also conducted in strata 54, 55, and 57–59. Surveys in strata 57–59 were discontinued in 2011 due to a reduction in aviation staff. In 2012, stratum 55 was discontinued primarily because it overlapped with an existing ground survey. In 2017, stratum 54 was discontinued due to increased aviation hazards such as wind turbines and power lines. None of the discontinued strata in the eastern survey are part of existing management frameworks. In Prairie and Parkland Canada and the northcentral U.S., aerial waterfowl counts are corrected annually for visibility bias by conducting ground counts along a subsample of survey segments. In some northern regions of the traditional survey area, visibility corrections were derived from past helicopter surveys. In the eastern survey area, duck estimates are adjusted using visibility-correction factors derived from a comparison of airplane and helicopter counts. Annual estimates of duck abundance are available since 1955 for the traditional survey area and since 1996 for the eastern survey area (except stratum 69); however, some portions of the eastern survey area have been surveyed since 1990 (strata 51–53, 56, 63–64, 66–68, 70–71). In the traditional survey area, visibility-corrected estimates of pond abundance in Prairie Canada are available since 1961, and in the northcentral U.S. since 1974. Several provinces and states also conduct breeding waterfowl surveys using various methods; some have survey designs that allow for calculation of measures of precision for their estimates. Information about habitat conditions was supplied primarily by biologists working in those survey areas. Unless otherwise noted, z-tests were used for assessing statistical significance, with alpha levels set at 0.1; P-values are given in tables along with wetland and waterfowl estimates.

Since 1990, the U.S. Fish and Wildlife Service (USFWS) has conducted aerial transect surveys using airplanes in portions of the eastern survey area, similar to those in the traditional survey area, to estimate waterfowl abundance. Additionally, the Canadian Wildlife Service (CWS) has

conducted a helicopter-based aerial plot survey in core American black duck breeding regions of Ontario, Quebec, and the Atlantic Provinces. Initially, data from these surveys were analyzed separately despite overlap in geographic areas of inference. In 2004, the USFWS and CWS agreed to integrate the two surveys, produce composite estimates from both sets of survey data, and expand the geographic scope of the survey in eastern North America. Consequently, since 2005, waterfowl abundances for eastern North America have been estimated using a hierarchical-modeling approach that combines USFWS and CWS data (Zimmerman et al. 2012). In cases where the USFWS has traditionally not recorded observations to the species level (e.g., mergansers, goldeneyes), estimates are produced for multi-species groupings. Previously, this report provided composite estimates for the eastern survey area using data collected in strata 51, 52, 63, 64, 66–68, and 70–72, which corresponds to the area covered by the CWS plot survey. These strata contain either (1) both USFWS airplane survey transects and CWS helicopter plots or (2) only helicopter plots (strata 71 and 72). Beginning this year, eastern breeding waterfowl population estimates will be presented at the full eastern survey scale (strata 51–53, 56, 62–72) or eastern North America scale, depending on the breeding distribution of the species. The eastern North America scale includes the full eastern survey area plus data from the Atlantic Flyway Breeding Waterfowl Survey (AFBWS, Sauer et al. 2014). The AFBWS is a ground-based survey conducted annually from Virginia north to New Hampshire. The time series at these larger scales is shorter (1998–present) but provides a more complete assessment of the status of waterfowl in the east. We provide a comparison of the time series at the plot survey area scale, which was presented in past versions of this report, to the total eastern survey area for each species.

For widely distributed and abundant species including American black ducks, mallards, green-winged teal, ring-necked ducks, goldeneyes (common and Barrow's) and mergansers (common, red-breasted, and hooded), composite estimates of abundance were constructed using a hierarchical model (Zimmerman et al. 2012) which estimated the mean count per unit area surveyed for each stratum, year, and method (i.e., airplane or helicopter). These mean counts were then extrapolated over the area of each stratum to produce a stratum/year/method-specific population estimate. Estimates from the airplane surveys were adjusted for visibility bias by multiplying them by the total CWS helicopter survey estimates for all years, divided by the total USFWS airplane survey estimates for all years that the two surveys overlapped. For strata containing both CWS and USFWS surveys (51, 52, 63, 64, 66–68, and 70), USFWS estimates were adjusted by visibility-correction factors derived from CWS plot estimates, and the CWS and adjusted USFWS estimates were then averaged to derive stratum-level estimates. For strata containing just USFWS surveys (strata 53, 56, 62, and 69) visibility-correction factors based on the ratio of counts from helicopters to fixed-wing aircraft along selected segments were used to adjust counts (Zimmerman et al. 2012). No visibility adjustments were made for strata with only CWS plots (strata 71 and 72). For two species groups, goldeneyes and mergansers, for which there are many survey units with no observations, a zero-inflated Poisson distribution (Martin et al. 2005) was used to fit the model. Using this technique, the binomial probability of encountering the species on a transect or a plot is modeled separately. Not enough green-winged teal, ring-necked ducks, goldeneyes, and mergansers were were counted in the AFBWS to fit the models for those species at the eastern North America scale. Black duck and mallard counts were adequate to fit the model to the AFBWS data and derive breeding population estimates at the eastern North America scale. However, due to differences in how the indicated pairs are calculated between the eastern survey area and the AFBWS for American black ducks (described below), we did not combine data from these two surveys for this species. Therefore, we present estimates for American black ducks, green-winged teal, ring-necked ducks, goldeneyes, and mergansers at the eastern survey scale, and estimates for mallards at the eastern North Amer-

ica scale. The zero-inflated Poisson modeling approach was not adequate for the following species that occur at lower densities and are more patchily distributed in the eastern survey area: scaup (lesser [*Aythya affinis*] and greater [*A. marila*]), scoters (black [*Melanitta americana*], white-winged [*M. fusca*], and surf [*M. perspicillata*]), bufflehead (*Bucephala albeola*), and American wigeon (*Anas americana*). This model-based approach and changes in analytical procedures for some species may preclude comparisons with results from previous reports. We will continue to investigate methods that might allow us to estimate abundance of these rarer species within a hierarchical-modeling framework.

To produce a consistent index for American black ducks, total indicated pairs are calculated using the CWS method of scaling observed pairs. The CWS scaling is based on sex-specific observations collected during previous CWS helicopter surveys in eastern Canada, which indicated that approximately 50% of black duck pair observations are actually two males. Thus, observed black duck pairs are scaled by 1.5 rather than the 1.0 scaling traditionally applied by the USFWS. These indicated pairs are then used to calculate indicated birds based on the USFWS protocol. For all other species, the USFWS definitions are used to calculate indicated pairs and indicated birds (see Zimmerman et al. 2012 for further details).

Total Duck Species Composition

In the traditional survey area, our estimate of total ducks excludes scoters, eiders (common [*Somateria mollissima*], king [*S. spectabilis*], spectacled [*S. fisheri*], and Steller's [*Polysticta stelleri*]), long-tailed ducks (*Clangula hyemalis*), mergansers, and wood ducks (*Aix sponsa*) because the traditional survey area does not include a large portion of their breeding ranges (Smith 1995).

Mallard Fall-flight Index

The mallard fall-flight index is a prediction of the size of the fall abundance of mallards originating from the mid-continent region of North America. For management purposes, the mid-continent population has historically been composed of mallards originating from the WBPHS traditional survey area, as well as Michigan, Minnesota, and Wisconsin. However, since 2008, the status of western mallards has been considered separately in setting regulations for the Pacific Flyway, and thus Alaska–Yukon mallards (strata 1–12) have been removed from the mid-continent stock. The fall-flight index is based on the mallard models used for adaptive harvest management and considers breeding population size, habitat conditions, adult summer survival, and the projected fall age ratio (young/adult). The projected fall age ratio is predicted from models that describe how age ratios vary with changes in spring population size and Canadian pond abundance. The fall-flight index represents a weighted average of the fall flights predicted by the four alternative models of mallard population dynamics used in adaptive harvest management (U.S. Fish and Wildlife Service 2018).

Results and Discussion

2018 Overall Habitat Conditions and Population Status

In general, habitat conditions during the 2018 WBPHS were similar to or declined relative to 2017, with a few exceptions (Figure 1). Much of the Canadian prairies experienced average fall and winter precipitation and below-average spring precipitation. Fall and winter temperatures were mainly average. However, well-below-average temperatures were recorded February–April 2018 and were well above average in May 2018. The U.S. prairies experienced average to above-average precipitation but had more variable conditions. Habitat conditions generally declined northward, particularly near the Montana–North Dakota border with Canada. The total pond estimate (Prairie Canada and northcentral U.S. combined) was 5.2 ± 0.2 million, which was 14% below the 2017 estimate of 6.1 ± 0.2 million and similar to the long-term average of 5.2 ± 0.03 million (Table 1, Figure 2). The 2018 estimate of ponds in Prairie Canada was

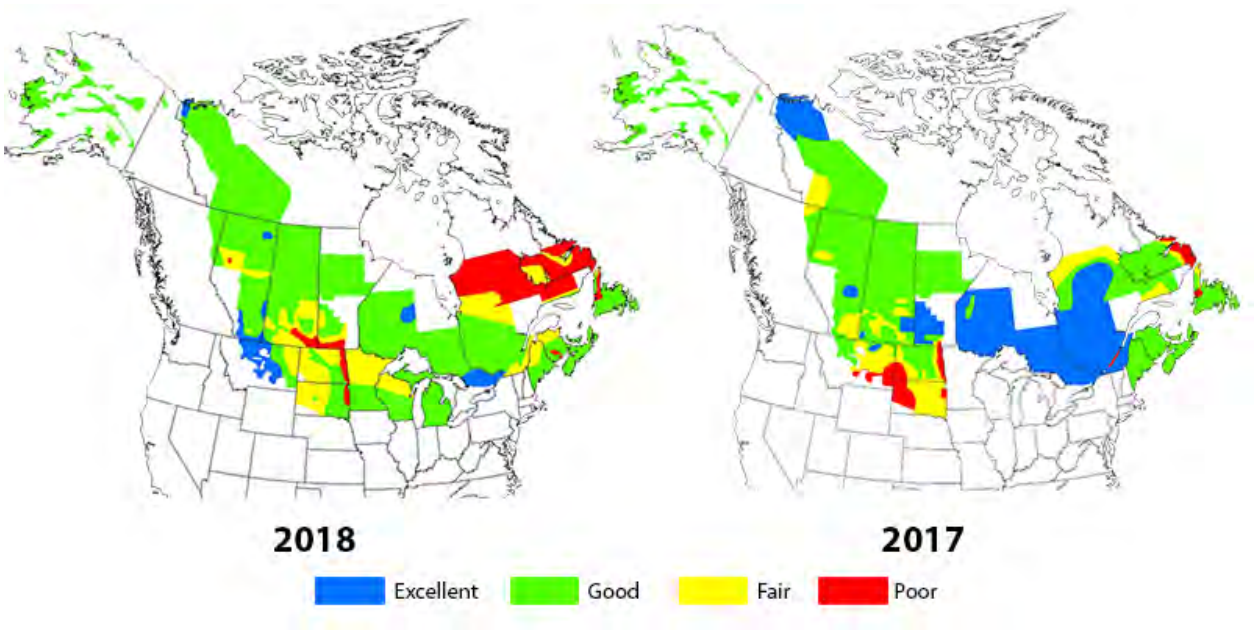

Figure 1. Breeding waterfowl habitat conditions during the 2018 and 2017 Waterfowl Breeding Population and Habitat Surveys, as judged by U.S. Fish and Wildlife Service and Canadian Wildlife Service biologists.

3.7 ± 0.1 million. This estimate was 15% below the 2017 estimate of 4.3 ± 0.2 million and similar to the long-term average (3.5 ± 0.02 million). The 2018 pond estimate for the northcentral U.S. was 1.6 ± 0.09 million, which was similar to the 2017 estimate (1.8 ± 0.09 million) and the long-term average (1.7 ± 0.01 million). Spring phenology and timing of ice-out was normal or slightly delayed in places within the traditional survey area. Alaska experienced near-normal temperatures and average to above-average precipitation. The boreal forest experienced generally average precipitation and temperatures, similar to the Canadian prairies. Habitat quality generally declined across the survey area compared to last year, with the exception of southern Alberta and eastern Montana which improved. Overall habitat quality remains good over a large portion traditional survey area and should lead to average waterfowl production this year.

Conditions in much of the eastern survey area declined or remained similar relative to 2017. The region experienced mainly average precipitation since September 2017 and variable fall and winter temperatures. The entire region had well-below-average temperatures in April 2018 that continued into May in more northerly areas. Spring phenology and ice-out were generally normal to much later than normal, the latter mainly in northern Quebec and Labrador. Conditions for waterfowl production generally declined to fair or good with northern areas affected by a late thaw and localized flooding farther south.

In the traditional survey area, the total duck population estimate was 41.2 ± 0.7 million birds. This estimate was 13% below the 2017 estimate of 47.3 ± 0.8 million and 17% higher than the long-term average (1955–2017). In the eastern Dakotas, total duck numbers were similar to the 2017 estimate but 33% above the long-term average. The total duck estimate in southern Alberta was 14% below last year's estimate and 28% above the long-term average. The total duck estimate was 30% lower than last year's in southern Saskatchewan and 6% above the long-term average. In southern Manitoba, the total duck population estimate was similar to last year's estimate and the long-term average. The total duck estimate in central and northern Alberta–northeastern British Columbia–Northwest Territories was 13% lower than last year's estimate

Table 1. Estimated number (in thousands) of May ponds in portions of Prairie and Parkland Canada and the northcentral U.S.

			Change from 2017			Change from LTA	
Region	2018	2017	%	*P*	LTA[a]	%	*P*
Prairie & Parkland Canada							
S. Alberta	1,179	1,168	+1	0.921	774	+52	<0.001
S. Saskatchewan	1,936	2,449	−21	0.003	2,089	−7	0.209
S. Manitoba	546	713	−23	0.036	662	−18	0.018
Subtotal	3,660	4,330	−15	0.002	3,525	+4	0.365
Northcentral U.S.							
Montana & western Dakotas	753	561	+34	0.034	575	+31	0.030
Eastern Dakotas	814	1,205	−32	<0.001	1,123	−27	<0.001
Subtotal	1,567	1,766	−11	0.124	1,698	−8	0.152
Total	5,227	6,096	−14	0.001	5,236	0[b]	0.963

[a] Long-term average. Prairie and and Parkland Canada, 1961–2017; northcentral U.S. and Total 1974–2017.
[b] Rounded values mask change in estimates.

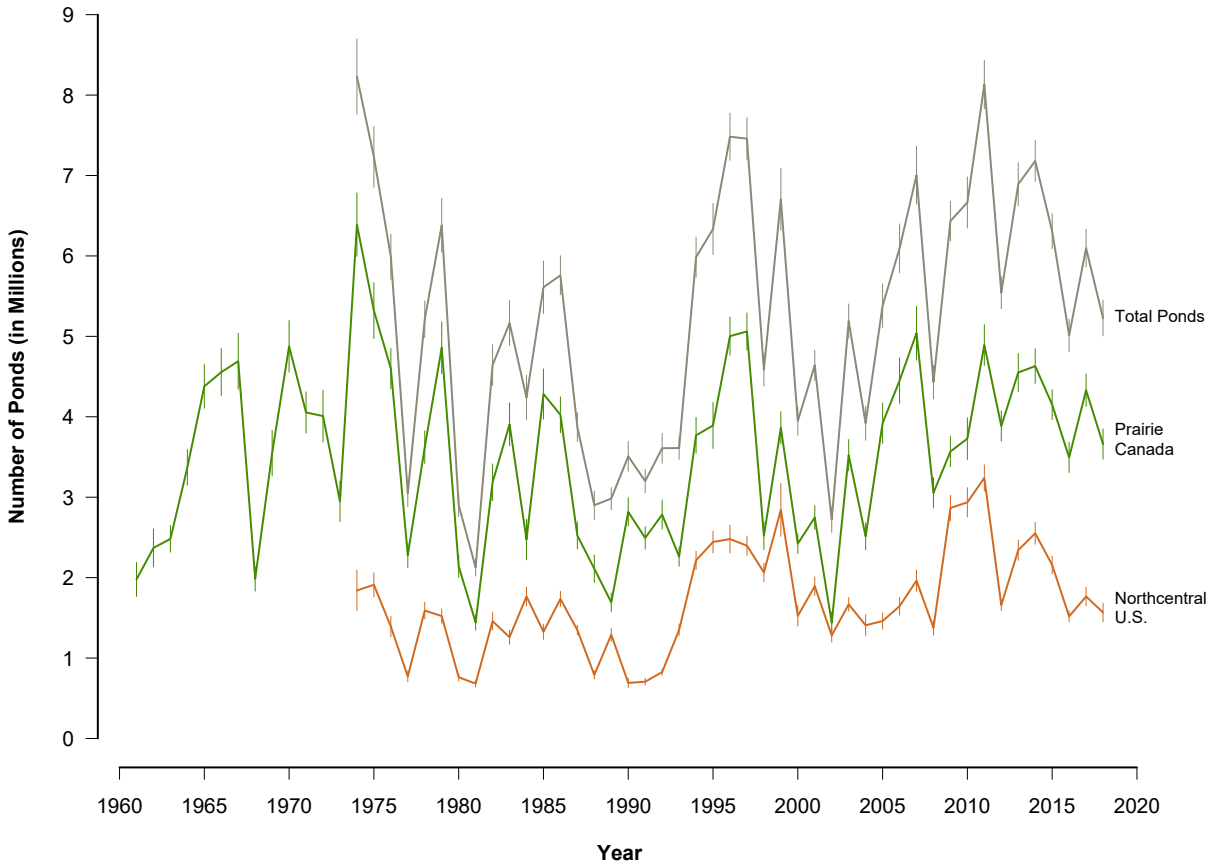

Figure 2. Number of ponds in May and 90% confidence intervals in Prairie Canada, the northcentral U.S., and both areas combined (Total ponds).

Table 2. Total duck[a] breeding population estimates (in thousands) for regions in the traditional survey area.

			Change from 2017			Change from LTA	
Region	2018	2017	%	*P*	LTA[b]	%	*P*
Alaska–Yukon Territory–Old Crow Flats	3,381	3,987	−15	0.030	3,703	−9	0.063
C. & n. Alberta–n.e. British Columbia–NWT	9,916	11,423	−13	0.006	7,458	+33	<0.001
N. Saskatchewan–n. Manitoba–w. Ontario	3,167	2,561	+24	0.014	3,445	−8	0.140
S. Alberta	5,546	6,444	−14	0.029	4,348	+28	<0.001
S. Saskatchewan	8,492	12,152	−30	<0.001	7,989	+6	0.059
S. Manitoba	1,665	1,748	−5	0.581	1,555	+7	0.330
Montana & western Dakotas	2,239	2,207	+1	0.868	1,737	+29	<0.001
Eastern Dakotas	6,787	6,744	+1	0.915	5,121	+33	<0.001
Total	41,193	47,266	−13	<0.001	35,355	+17	<0.001
Other regions							
British Columbia	346	351	−1	0.867	331	+4	0.389
California	549	394	+39	0.034	554	−1	0.943
Michigan	452	684	−34	0.030	631	−28	0.005
Northeast U.S.[c]	1,448	1,331	+9	0.662	1,368	+6	0.629
Oregon	294	240	+23	0.186	262	+12	0.350
Washington	281	242	+16	0.127	177	+59	<0.001
Wisconsin	439	479	−8	0.563	441	0[d]	0.964

[a] Includes 10 species in Appendix C.3, plus American black ducks, ring-necked ducks, goldeneyes, bufflehead, and ruddy ducks (*Oxyura jamaicensis*); excludes eiders, long-tailed ducks, scoters, mergansers, and wood ducks.
[b] Long-term average for regions in the traditional survey area, 1955–2017; years for other regions vary (see Appendix C.2)
[c] Includes all or portions of CT, DE, MD, MA, NH, NJ, NY, PA, RI, VT, and VA.
[d] Rounded values mask change in estimates.

but 33% above the long-term average. The estimate in the northern Saskatchewan–northern Manitoba–western Ontario survey area was 24% above the 2017 estimate and similar to the long-term average. The total duck estimate in the Montana–western Dakotas area was similar to the 2017 estimate but 29% above the long-term average. In the Alaska–Yukon Territory–Old Crow Flats region, the total duck estimate was 15% below last year's estimate and 9% below the long-term average.

Several states and provinces conduct breeding waterfowl surveys in areas outside the geographic extent of the WBPHS (estimates are provided in the Regional Popluation and Habitat Status section of this report and in Appendix C.2). In California, Oregon, Washington, British Columbia, Michigan, Wisconsin, and the northeast U.S., measures of precision for estimates of total duck numbers are available (Table 2). The total duck estimate in California was 39% above the 2017 estimate and similar to the long-term average (1992–2017). Oregon's 2018 total duck estimate was similar to 2017 and the long-term average (1994–2017). In Washington the total duck estimate was unchanged from the 2017 estimate, and 59% above the long-term average (2010–2017). British Columbia's total duck estimate was similar to the 2017 estimate and the long term average (2006–2017). In Michigan, the total

Table 3. Mallard breeding population estimates (in thousands) for regions in the traditional survey area.

			Change from 2017			Change from LTA	
Region	2018	2017	%	*P*	LTA[a]	%	*P*
Alaska–Yukon Territory–Old Crow Flats	451	538	−16	0.202	386	+17	0.153
C. & n. Alberta–n.e. British Columbia–NWT	1,550	1,837	−16	0.171	1,143	+36	0.004
N. Saskatchewan–n. Manitoba–w. Ontario	1,277	1,074	+19	0.323	1,147	+11	0.396
S. Alberta	1,328	1,291	+3	0.795	1,094	+21	0.020
S. Saskatchewan	2,094	2,725	−23	0.001	2,118	−1	0.827
S. Manitoba	460	587	−22	0.156	395	+16	0.146
Montana & western Dakotas	560	658	−15	0.237	532	+5	0.661
Eastern Dakotas	1,536	1,777	−14	0.233	1,080	+42	0.001
Total	9,255	10,488	−12	0.006	7,897	+17	<0.001
Eastern survey area	1,056	1,107	−4	––[b]	1,249	−15	––[b]
Other regions							
British Columbia	79	71	+12	0.347	79	+1	0.942
California	273	198	+38	0.158	340	−20	0.122
Michigan	251	298	−16	0.401	344	−27	0.046
Minnesota	295	214	+38	0.151	228	+30	0.150
Northeast U.S.[c]	482	448	+7	0.550	709	−32	<0.001
Oregon	97	72	+35	0.050	91	+7	0.569
Washington	125	103	+21	0.123	83	+51	<0.001
Wisconsin	217	181	+20	0.325	182	+19	0.219

[a] Long-term average. Traditional survey area 1955–2017; eastern survey area 1990–2017; years for other regions vary (see Appendix C.2).
[b] *P*-values not provided because these data were analyzed using Bayesian methods.
[c] Includes all or portions of CT, DE, MD, MA, NH, NJ, NY, PA, RI, VT, and VA.

duck estimate was 34% below 2017 estimate and 28% below the long-term average (1991–2017). Wisconsin's 2018 total duck estimate was similar to the 2017 estimate and the long-term average (1973–2017). In Minnesota, which does not have a measure of precision for total duck numbers, the 2018 estimate of total ducks was 9% higher than the 2017 estimate (1968–2017). The total breeding duck estimate in the northeast U.S. was similar to the 2017 estimate and the long-term average (1993–2017).

Trends and annual breeding population estimates for 10 principal duck species for the traditional survey area are provided in this report (Tables 3–12, Figure 3, Appendix C.3). Percent change was computed prior to rounding of estimates and therefore may not match the rounded estimates presented in the tables and text. Estimated mallard abundance was 9.3 ± 0.3 million, which was 12% lower than the 2017 estimate of 10.5 ± 0.3 million but 17% above the long-term average of 7.9 ± 0.04 million (Table 3). In the eastern Dakotas, the mallard estimate was similar to last year's count and 42% above the long-term average. The mallard estimate in southern Alberta was similar to last year's estimate and 21% above the long-term average. In the central and northern Alberta–northeastern

British Columbia–Northwest Territories region, the mallard estimate was similar to the 2017 estimate and 36% above the long-term average. In the Montana–western Dakotas, northern Saskatchewan–northern Manitoba–western Ontario, Alaska–Yukon Territory–Old Crow Flats, and southern Manitoba survey areas, the mallard estimates were similar to their 2017 estimates and long-term averages. Mallard numbers in southern Saskatchewan were 23% below the 2017 estimate and similar to the long-term average.

The estimated abundance of mallards in eastern North America was 1.1 ± 0.12 million, which was similar to the 2017 estimate but 15% below the long-term average. Mallard abundances with estimates of precision are also available for other areas where surveys are conducted (California, Oregon, Washington, British Columbia, Nevada, Minnesota, Michigan, Wisconsin, and the northeast U.S.; Table 3). Mallard numbers in California were similar to last year and the long-term average (1992–2017). The Oregon mallard estimate was 35% above the 2017 estimate and similar to the long-term average (1994–2017). In Washington, mallard numbers were similar to the 2017 estimate and 51% above the long-term average (2010–2017). British Columbia mallard numbers were similar to last year and the long-term average (2006–2017). In Nevada, the mallard estimate was 118% above the 2017 estimate and 85% above the long-term average (2009–2017). Minnesota mallard numbers were similar to last year and the long-term average (1968–2017). In Michigan, the 2018 mallard estimate was similar to the 2017 estimate and 27% below the long-term average (1991–2017). Wisconsin mallard numbers were similar to last year's estimate and the long-term average (1973–2017). The northeast U.S. mallard estimate was similar to the 2017 estimate and 32% below the long-term average (1993–2017).

In the traditional survey area the 2018 estimate for blue-winged teal (6.4 ± 0.3 million) was 18% below the 2017 estimate and 27% above the long-term average of 5.1 ± 0.04 million (Table 7). Estimated abundance of gadwall (2.9 ± 0.2 million) was 31% below 2017 but 43% above the long-term average (Table 4). The 2018 northern shoveler estimate was similar to last year and 62% above the long-term average of 2.6 ± 0.02 million (Table 8). The estimated abundance of green-winged teal was 3.0±0.2 million, which was 16% below the 2017 estimate of 3.6 ± 0.2 million and 42% above the long-term average (2.1 ± 0.02 million; Table 6). Estimated abundance of redheads (1.0 ± 0.09 million) was similar to the 2017 estimate but 38% above the long-term average of 0.7±0.01 million (Table 10). Northern pintail abundance (2.4 ± 0.2 million) was 18% lower than the 2017 estimate and 40% below the long-term average of 4.0 ± 0.03 million (Table 9). Abundance estimates for American wigeon (2.8 ± 0.2 million) and canvasbacks (0.7 ± 0.06 million) were similar to their 2017 estimates and their long-term averages of 2.6 ± 0.02 million and 0.6±0.01 million, respectively (Table 5 and Table 11). The combined estimate of lesser and greater scaup (4.0 ± 0.2 million) was similar to the 2017 estimate and 20% below the long-term average of 5.0 ± 0.04 million (Table 12).

In the eastern survey area, the estimate of goldeneyes was 0.5 ± 0.13 million, which was similar to the 2017 estimate and 17% below the 1998–2017 average. Estimates of green-winged teal (0.3±0.08 million) and mergansers (0.7±0.07 million) were similar to their 2017 estimates and 1998–2017 averages. Ring-necked ducks (0.6 ± 0.13 million) were similar to last year and the long-term average (Table 13, Figure 4, Appendix C.4). A time series for assessing changes in American black duck population status is provided by the breeding waterfowl surveys conducted by the USFWS and CWS in the eastern survey area (Table 13, Figure 4). The 2018 estimate of American black ducks in the eastern survey area was 0.7 ± 0.07 million, which similar to last year's estimate of 0.8 ± 0.09 million, and 20% below the 1998–2017 average. In addition, black duck population estimates for northeastern states from New Hampshire south to Virginia were also available from the Atlantic Flyway Breeding Waterfowl Survey. The 2018 estimate of 35,400 was similar to the 2017 estimate and 39% lower than the long-term (1993–2017) average of 58,300.

Trends in wood duck populations are available from the North American Breeding Bird Survey (BBS). The BBS, a series of roadside

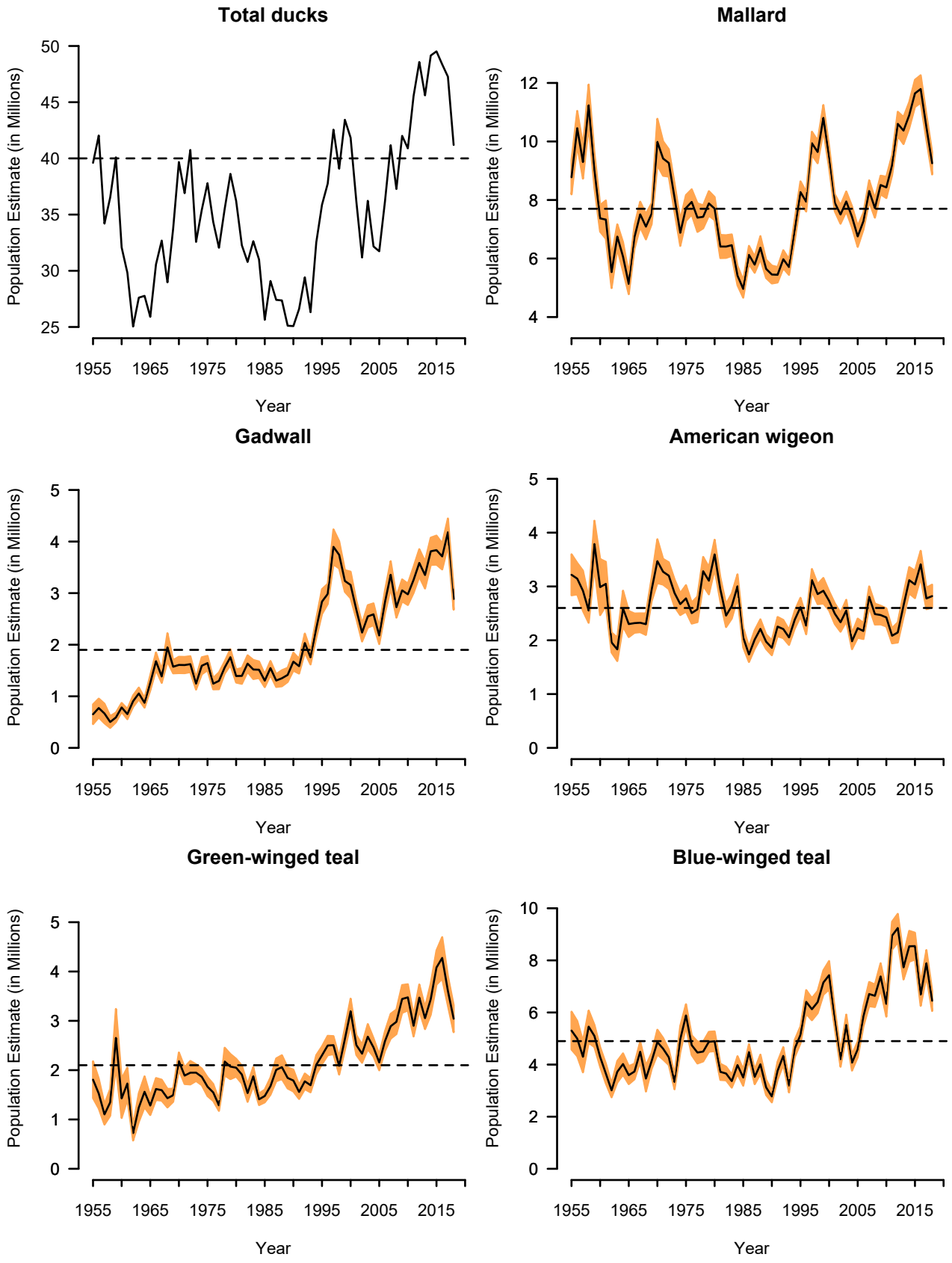

Figure 3. Breeding population estimates, 90% confidence intervals, and North American Waterfowl Management Plan population goals (dashed line; North American Waterfowl Management Plan Committee 2014) for selected species in the traditional survey area (strata 1–18, 20–50, 75–77).

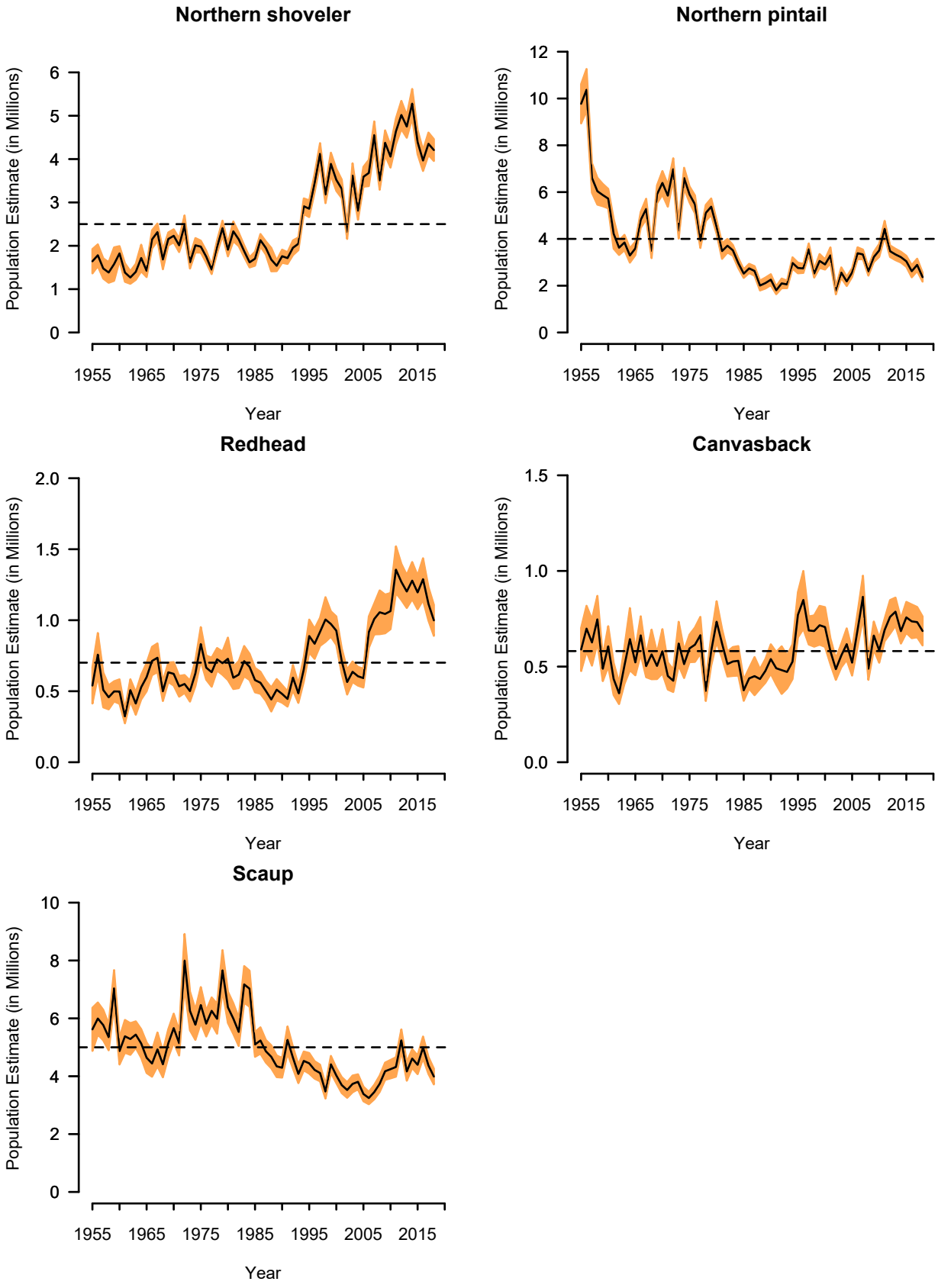

Figure 3. Continued.

Table 4. Gadwall breeding population estimates (in thousands) for regions in the traditional survey area.

			Change from 2017			Change from LTA	
Region	2018	2017	%	*P*	LTA[a]	%	*P*
Alaska–Yukon Territory–Old Crow Flats	0	1	−100	0.321	2	−100	<0.001
C. & n. Alberta–n.e. British Columbia–NWT	51	59	−14	0.686	51	−1	0.971
N. Saskatchewan–n. Manitoba–w. Ontario	8	7	+12	0.861	26	−70	<0.001
S. Alberta	418	873	−52	<0.001	340	+23	0.255
S. Saskatchewan	1,218	1,496	−19	0.052	686	+78	<0.001
S. Manitoba	101	125	−19	0.424	79	+27	0.399
Montana & western Dakotas	422	558	−24	0.170	223	+90	<0.001
Eastern Dakotas	668	1,060	−37	0.008	609	+10	0.537
Total	2,886	4,180	−31	<0.001	2,015	+43	<0.001

[a] Long-term average, 1955–2017.

Table 5. American wigeon breeding population estimates (in thousands) for regions in the traditional survey area.

			Change from 2017			Change from LTA	
Region	2018	2017	%	*P*	LTA[a]	%	*P*
Alaska–Yukon Territory–Old Crow Flats	597	644	−7	0.553	560	+7	0.469
C. & n. Alberta–n.e. British Columbia–NWT	1,326	1,424	−7	0.613	934	+42	0.006
N. Saskatchewan–n. Manitoba–w. Ontario	147	71	+107	0.012	227	−35	0.005
S. Alberta	208	188	+11	0.587	278	−25	0.018
S. Saskatchewan	272	296	−8	0.602	397	−32	<0.001
S. Manitoba	12	6	+83	0.073	52	−77	<0.001
Montana & western Dakotas	118	54	+121	0.037	112	+6	0.826
Eastern Dakotas	140	95	+47	0.420	60	+134	0.062
Total	2,820	2,777	+2	0.849	2,619	+8	0.232

[a] Long-term average, 1955–2017.

Table 6. Green-winged teal breeding population estimates (in thousands) for regions in the traditional survey area.

			Change from 2017			Change from LTA	
Region	2018	2017	%	*P*	LTA[a]	%	*P*
Alaska–Yukon Territory–Old Crow Flats	449	617	−27	0.050	418	+7	0.559
C. & n. Alberta–n.e. British Columbia–NWT	1,587	1,816	−13	0.413	889	+79	<0.001
N. Saskatchewan–n. Manitoba–w. Ontario	187	136	+38	0.098	200	−6	0.525
S. Alberta	190	342	−44	0.083	207	−8	0.614
S. Saskatchewan	324	472	−31	0.021	279	+16	0.219
S. Manitoba	85	75	+14	0.484	56	+51	0.011
Montana & western Dakotas	49	27	+85	0.074	41	+21	0.415
Eastern Dakotas	171	121	+41	0.196	61	+183	<0.001
Total	3,043	3,605	−16	0.076	2,150	+42	<0.001

[a] Long-term average, 1955–2017.

Table 7. Blue-winged teal breeding population estimates for regions in the traditional survey area.

			Change from 2017			Change from LTA	
Region	2018	2017	%	*P*	LTA[a]	%	*P*
Alaska–Yukon Territory–Old Crow Flats	0	0	0		1	−100	<0.001
C. & n. Alberta–n.e. British Columbia–NWT	490	579	−15	0.522	283	+73	0.022
N. Saskatchewan–n. Manitoba–w. Ontario	71	47	+52	0.459	228	−69	<0.001
S. Alberta	1,171	1,644	−29	0.111	643	+82	0.001
S. Saskatchewan	1,700	2,820	−40	<0.001	1,454	+17	0.095
S. Manitoba	341	300	+14	0.651	376	−9	0.657
Montana & western Dakotas	399	528	−25	0.215	312	+28	0.179
Eastern Dakotas	2,279	1,970	+16	0.209	1,783	+28	0.004
Total	6,450	7,889	−18	0.004	5,080	+27	<0.001

[a] Long-term average, 1955–2017.

Table 8. Northern shoveler breeding population estimates (in thousands) for regions in the traditional survey area.

			Change from 2017			Change from LTA	
Region	2018	2017	%	*P*	LTA[a]	%	*P*
Alaska–Yukon Territory–Old Crow Flats	367	434	−15	0.328	299	+23	0.097
C. & n. Alberta–n.e. British Columbia–NWT	415	584	−29	0.062	243	+71	0.006
N. Saskatchewan–n. Manitoba–w. Ontario	22	19	+17	0.696	38	−42	0.007
S. Alberta	1,027	872	+18	0.279	436	+136	<0.001
S. Saskatchewan	1,066	1,501	−29	0.008	799	+33	0.004
S. Manitoba	109	126	−13	0.569	113	−4	0.865
Montana & western Dakotas	387	218	+77	0.015	173	+124	<0.001
Eastern Dakotas	814	600	+36	0.070	496	+64	<0.001
Total	4,208	4,353	−3	0.607	2,597	+62	<0.001

[a] Long-term average, 1955–2017.

Table 9. Northern pintail breeding population estimates (in thousands) for regions in the traditional survey area.

			Change from 2017			Change from LTA	
Region	2018	2017	%	*P*	LTA[a]	%	*P*
Alaska–Yukon Territory–Old Crow Flats	651	757	−14	0.571	919	−29	0.016
C. & n. Alberta–n.e. British Columbia–NWT	497	675	−26	0.073	372	+34	0.056
N. Saskatchewan–n. Manitoba–w. Ontario	22	10	+122	0.158	36	−39	0.089
S. Alberta	344	301	+14	0.426	650	−47	<0.001
S. Saskatchewan	269	561	−52	<0.001	1,114	−76	<0.001
S. Manitoba	11	31	−64	0.026	97	−89	<0.001
Montana & western Dakotas	193	106	+82	0.012	254	−24	0.048
Eastern Dakotas	379	449	−16	0.495	507	−25	0.010
Total	2,365	2,889	−18	0.040	3,949	−40	<0.001

[a] Long-term average, 1955–2017.

Table 10. Redhead breeding population estimates (in thousands) for regions in the traditional survey area.

			Change from 2017			Change from LTA	
Region	2018	2017	%	*P*	LTA[a]	%	*P*
Alaska–Yukon Territory–Old Crow Flats	0	0	0		1	−100	<0.001
C. & n. Alberta–n.e. British Columbia–NWT	78	46	+68	0.101	41	+92	0.034
N. Saskatchewan–n. Manitoba–w. Ontario	19	12	+61	0.618	25	−22	0.687
S. Alberta	245	221	+11	0.690	131	+87	0.002
S. Saskatchewan	290	528	−45	0.010	240	+21	0.381
S. Manitoba	135	131	+3	0.932	76	+78	0.094
Montana & western Dakotas	31	2	+1,339	0.024	11	+176	0.120
Eastern Dakotas	202	175	+16	0.454	200	+1	0.947
Total	999	1,115	−10	0.353	724	+38	0.001

[a] Long-term average, 1955–2017.

Table 11. Canvasback breeding population estimates (in thousands) for regions in the traditional survey area.

			Change from 2017			Change from LTA	
Region	2018	2017	%	*P*	LTA[a]	%	*P*
Alaska–Yukon Territory–Old Crow Flats	85	87	−2	0.970	84	+1	0.987
C. & n. Alberta–n.e. British Columbia–NWT	108	110	−3	0.940	77	+39	0.298
N. Saskatchewan–N. Manitoba–w. Ontario	43	37	+17	0.760	50	−16	0.592
S. Alberta	73	64	+14	0.619	66	+10	0.638
S. Saskatchewan	208	295	−29	0.066	202	+3	0.831
S. Manitoba	81	77	+5	0.861	56	+43	0.202
Montana & western Dakotas	29	14	+110	0.131	10	+195	0.013
Eastern Dakotas	61	50	+23	0.453	43	+44	0.117
Total	686	733	−6	0.587	589	+16	0.104

[a] Long-term average, 1955–2017.

Table 12. Scaup (greater and lesser combined) breeding population estimates (in thousands) for regions in the traditional survey area.

			Change from 2017			Change from LTA	
Region	2018	2017	%	*P*	LTA[a]	%	*P*
Alaska–Yukon Territory–Old Crow Flats	670	781	−14	0.398	896	−25	0.007
C. & n. Alberta–n.e. British Columbia–NWT	1,965	2,238	−12	0.267	2,521	−22	0.001
N. Saskatchewan–n. Manitoba–w. Ontario	268	315	−15	0.392	541	−50	<0.001
S. Alberta	260	266	−2	0.906	329	−21	0.091
S. Saskatchewan	409	477	−14	0.472	418	−2	0.882
S. Manitoba	82	70	+17	0.603	125	−34	0.018
Montana & western Dakotas	28	24	+18	0.665	47	−40	0.022
Eastern Dakotas	307	200	+53	0.101	129	+138	<0.001
Total	3,989	4,372	−9	0.221	5,005	−20	<0.001

[a] Long-term average, 1955–2017.

routes surveyed during May and June each year, provides the only long-term range-wide breeding population index for this species. Wood ducks are encountered with low frequency along BBS routes, which limits the amount and quality of available information (Sauer and Droege 1990). However, hierarchical analysis of these data (J. Sauer, U.S. Geological Survey Biological Resources Division, unpublished data) incorporated adjustments for spatial and temporal variation in BBS route quality, observer skill, and other factors that may affect detectability (Link and Sauer 2002). This analysis also produces annual abundance indices and measures of variance, in addition to the trend estimates (average % change per year) and associated 95% credible intervals (LCL, UCL in parentheses following trend estimates) presented here. In the Atlantic and Mississippi flyways combined, the BBS wood duck index increased by an average of 1.57% (1.18%, 1.91%) per year over the entire survey period (1966–2017), 1.93% (1.34%, 2.51%) over the past 20 years (1998–2017), and 2.00% (0.89%, 3.12%) over the most recent (2008–2017) 10-year period. The Atlantic Flyway wood duck index increased 1.28% (0.69%, 1.82%) annually over the entire time series (1966–2017), 1.91% (0.99%, 2.86%) over the past 20 years (1998–2017), and 1.92% (0.08%, 3.74%) from 2008 to 2017. In the Mississippi Flyway, the corresponding BBS wood duck indices increased by 1.72% (1.23%, 2.19%, 1966–2017), 1.93% (1.19%, 2.66%, 1998–2017), and 2.04% (0.65%, 3.41%, 2008–2017; J. Sauer, U.S. Geological Survey Biological Resources Division, unpublished data). An independent wood duck population estimate was available from the Atlantic Flyway Breeding Waterfowl Survey for the northeast states from New Hampshire south to Virginia. The 2018 survey estimate of 394,400 (SE = 36,600) was similar to the 2017 (396,400, SE = 36,000) and 1993–2017 average (384,800, SE = 6,900) estimates.

Regional Habitat and Population Status

A description of habitat conditions and duck populations for each of the major breeding areas follows. In the past this information was taken from more detailed reports of specific regions. Although these reports are no longer produced, habitat and population status for each region will continue to be summarized in this report. More detailed information on regional waterfowl and habitat conditions during the May waterfowl survey is also

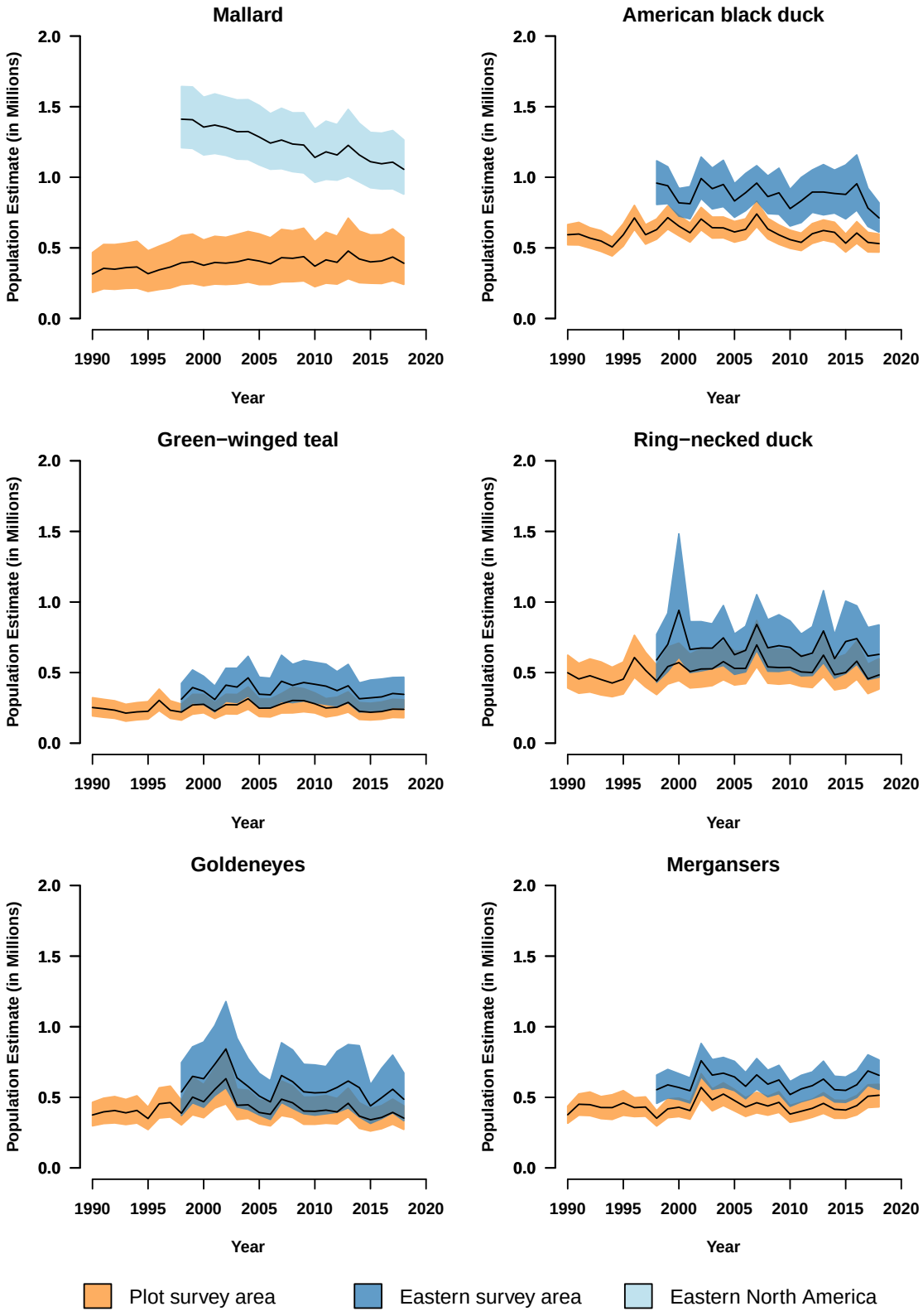

Figure 4. Breeding population estimates and 90% credible intervals (orange bands) from Bayesian hierarchical models for species in the eastern survey area. Two time series are presented to compare estimates published in previous versions of this report (Orange; strata 51, 52, 63, 64, 66–68, 70–72) and the scale at which estimates will be published beginning this year: eastern survey area (Blue; strata 51–53, 56, 62–72 for black ducks, green-winged teal, ring-necked ducks, goldeneye, and mergansers) and eastern North America (Light blue; eastern survey area plus the northeastern states from Virginia north to New Hampshire for mallards).

Table 13. Duck breeding population estimates for six most abundant species in the eastern survey area. Estimates for black ducks, green-winged teal, ring-necked ducks, goldeneye, and mergansers are at the eastern survey scale (strata 51–53, 56, 62–72) and mallards at the eastern North America scale (eastern survey area plus Virginia north to New Hampshire)

	2018	2017	% Change from 2017	Average[a]	% Change from average
Mallard	1,056	1,107	−4	1,249	−15[b]
American black duck	712	782	−9	886	−20[b]
Green-winged teal	346	352	−1	377	−9
Ring-necked duck	629	617	+2	694	−10
Goldeneyes (common and Barrow's)	486	557	−13	585	−17[b]
Mergansers (common, red-breasted, and hooded)	656	687	−4	606	+8

[a] Average for 1998–2017.
[b] Indicates significant change. Significance ($P \leq 0.10$) determined by non-overlap of Bayesian credibility intervals.

available on USFWS Division of Migratory Bird Management website (https://www.fws.gov/birds/surveys-and-data/population-surveys/aerial-ground-crew-blog.php).

Southern Alberta (strata 26–29, 75–76)
reported by biologist-pilot Jim Bredy

Fall of 2017 had slightly-above to above-average precipitation (upwards of 200%) over the northern region of the crew area and slightly-below to below-average (40–60%) across the southern region, whereas the precipitation was reversed during winter. Below-average to well-below-average precipitation (<40%) was received during spring 2018. Spring arrived very late, mainly due to temperatures averaging 5°C below normal from February–April 2018. Canadian Wildlife Service reports indicated more than a foot of snow on the ground in the Parklands and temperatures in the −20°C range in early April. Above-normal temperatures in late April and early May led to a quick thaw and rapid filling of smaller seasonal wetlands. Above-average winter precipitation in southern Alberta (strata 26–29) produced good-to-excellent habitat conditions. The quality of wetland habitat conditions deteriorated moving farther north and west into central Alberta (strata 75 and 76). Wetland water levels were lower than 2017 and many seasonal wetlands were dry. The heavily farmed areas of the central "Peace" region between Grand Prairie and Peace River remained in poor condition for nesting waterfowl due to tilled wetland basins and little associated upland habitat. Unseasonably high temperatures during May 2018 continued to dry out wetland basins. Increased waterfowl production is not expected from strata 75 and 76 but improved production in 2018 is expected from Edmonton southward to Montana border (strata 26–29).

May ponds were similar to the 2017 estimate and 52% above the long-term average. The total duck estimate was 14% below the 2017 estimate and 28% above the long-term average. The mallard estimate was similar to 2017 and 21% above the long-term average. Gadwalls were 52% below their 2017 estimate and similar to their long-term average. The American wigeon estimate was similar to last year but 25% below the long-term average. Green-winged teal were 44% below the 2017 estimate and similar the long-term average. The blue-winged teal, northern shoveler, and redhead estimates were similar to the 2017 estimates, and 82%, 136%, and 87% above the long-term averages, respectively. Northern pintails were similar to 2017 but 47% below the long-term average. Canvasbacks were similar to 2017 and their long-term average. Scaup were similar to their 2017 estimate and 21% below their long-term average.

Southern Saskatchewan (strata 30–33)
reported by biologist-pilot Phil Thorpe

Southern Saskatchewan has dried out over the last year but conditions varied widely across the survey area. Below-normal precipitation from summer through winter left many seasonal wetlands dry, and semi-permanent wetlands drawn-down. Spring precipitation was well below average. Little to no sheetwater was observed in the southern grasslands, and farmers hoped for some rain to help newly seeded fields. The Missouri Coteau had good water and ducks seemed in higher densities than normal and were likely crowding in from drier areas in the province. Phenology of vegetation appeared normal to slightly ahead of normal, and timing of the survey appeared good.

The majority of the survey area had fair-to-good production potential for waterfowl. The grasslands had fair-to-good production and recruitment potential, with a small pocket of excellent conditions in the southwest shortgrass prairie. Much drier conditions existed in the southeast corner of stratum 32, with little to no water observed in the Regina plain or east of the coteau, and those areas have poor recruitment potential. The northeast Parklands were drier but many wetlands remained flooded out of their boundaries, primarily from draining of smaller wetlands and carry-over water from previous years. Fair-to-good production was expected from the northeast Parklands because of the deeper, more stable wetlands that remained. The northwest Parklands should have good production. Lower wetland levels were observed in the grassland-parkland transition zone but enough water remained on the landscape to support good recruitment from the area. Overall, it should be a fair to good year for waterfowl recruitment in the southern Saskatchewan survey area was expected.

The 2018 May pond estimate in this survey area was 21% below the 2017 estimate and similar to the long-term average. Total duck abundance was 30% below last year and 6% above the long-term average. Mallards were 23% below their 2017 estimate and similar to the long-term average. Green-winged teal were 31% below last year and similar to their long-term average. Blue-winged teal were 40% below their 2017 estimate and 17% above the long-term average. Northern shovelers were 29% below the 2017 estimate but 33% above the long-term average. The gadwall estimate was 19% below last year and 77% above the long-term average. American wigeon were similar to last year's estimate but 32% lower than the long-term average. Northern pintails were 52% below last year and 76% below the long-term average. Redheads and canvasback estimates were 45% and 29% below the 2017 estimates, respectively, and remained similar to their long-term averages. Scaup were similar to their 2017 estimate and long-term average.

Southern Manitoba (strata 34–40; includes southeast Saskatchewan)
reported by biologist-pilot Sarah Yates

Southern Manitoba and southeastern Saskatchewan habitat conditions were significantly drier in 2018 compared to 2017. These were some of the driest conditions in the region in many years. Below-normal winter and spring precipitation (40–65 mm) was recorded in the crew area. Southern parts of Manitoba received no precipitation in April 2018. Winter and spring temperatures were below average as well, and ice thickness was at record high levels. The low temperatures, late thaw, and very dry conditions delayed phenology and lead to limited wetland availability and larger bird groupings in 2018.

Habitat quality in all strata was diminished in 2018 compared to 2017. No sheetwater was observed in any strata, very few seasonal wetlands remained, and the larger semi-permanent wetlands had extremely low water levels. Rivers, streams, and canals were either dried up or very low as well. Stratum 39 habitat conditions were poor on most transects, with better habitat near Oak Lake, Whitewater Lake, and Turtle Mountain Provincial Park. Heavily influenced by agriculture, stratum 38 typically ranks poor due to lack of habitat. This area was almost bone dry, and even artificial waterbodies (e.g., dugouts) were low. Pockets of wetlands persisted in southeastern Saskatchewan (stratum 35) but were rated poor to fair. Conditions were

improved near Yorkton but diminished to the southeast of Regina and near the Saskatchewan-Manitoba border. Conditions improved as we moved north into strata 34 and 40. These areas are generally rated good to excellent in most years; however, even these areas were noticeably drier in 2018 and were rated fair or good. Dry conditions persisted north into strata 37 and 36. Throughout both strata, wetlands were low, and many streams, canals, and large ditches were almost completely dry. Marshes on the big lakes (i.e., Manitoba, Winnipegosis, and Winnipeg) were lower than in previous years but still were considered good habitat.

The 2018 May pond estimate in this crew area was 23% below the 2017 estimate and 18% below the long-term average. The total duck estimate was similar to 2017 and the long-term average. Mallard and gadwall numbers were similar to 2017 and the long-term averages. American wigeon were 83% above their 2017 estimate and 77% below the long-term average. The blue-winged teal and northern shoveler estimates were similar to last year's and the long-term averages. Green-winged teal were unchanged from 2017 estimate yet 51% above the long-term average. Northern pintails were 64% below their 2017 estimate and 89% below the long-term average. Redheads were similar to 2017, and 78% above the long-term average. The canvasback estimate was similar to last year's estimate and the long-term average. Scaup were similar to their 2017 estimate but 34% below their long-term average.

Montana and western Dakotas (strata 41–44)
reported by biologist-pilot Rob Spangler

Over the past year, the Montana and western Dakotas crew area was characterized by average to above-average precipitation. Fall precipitation averaged 50–100% of normal in North Dakota and approximately 75–150% of normal in South Dakota. Montana had a very wet fall with precipitation over most of the state averaging 150–300% of normal. However, the exception was in the northeast portion of the state where precipitation averaged 50–100% of normal. Winter brought needed precipitation to most of the Dakotas. However, generally conditions were drier to the east in South Dakota and drier to the west in North Dakota. Montana had record amounts of precipitation (200–600%) over the winter. As spring progressed, conditions remained dry in central North Dakota and in western South Dakota. However, again, Montana had above-average precipitation (100–300%) during the spring, and conditions in areas near Malta and Billings and westward were some of the wettest on record.

Wetland conditions in western South Dakota (stratum 44) were mostly fair, with some good areas east of Pierre. The somewhat average precipitation year was not enough to overcome the dry conditions of the past several years. Drought continued to persist in western South Dakota; however, ponds and streams were more numerous than 2017. Habitat conditions improved somewhat in North Dakota (stratum 43) compared to last year, but overall, drought conditions continued. Wetland conditions in the southern half of Montana (stratum 42) were good to excellent. Record precipitation over the past year filled seasonal wetlands and produced sheetwater in many areas. This was quite a contrast to 2017 when conditions were poor near the Montana and Wyoming border. Generally, conditions improved moving westward, with areas near Billings, Winnet, Lewistown, and Malta supporting exceptionally high numbers of wetlands. Three years of higher-than-normal precipitation has greatly improved habitat in the western portions of stratum 42 near Great Falls, Choteau, and Cut Bank. Conditions improved from fair to excellent moving in a westward direction along the Montana and Canada border. The increase in wetland quality and quantity was expected to significantly benefit waterfowl production in Montana.

The 2018 May pond count in this crew area was 34% above last year's estimate and 31% above the long-term average. Total duck numbers were unchanged from 2017 but were 29% higher than the long-term average. The mallard and blue-winged teal estimates were similar to 2017 as well as their long-term averages. Northern shoveler numbers were 77% and 124% above their 2017 estimate and long-term average,

respectively. Green-winged teal and American wigeon were 85% and 121% above last year, respectively, and similar to their long-term averages. The estimate for gadwall remained unchanged from 2017 but were 90% above the long-term average. The northern pintail estimate was 82% above the 2017 estimate and 24% lower than the long-term average. Canvasbacks were similar to 2017 yet remained well above (195%) the long-term average. Redhead numbers dramatically increased (1,339%) from 2017 and were similar to the long-term average. The scaup estimate was similar to last year but 40% lower than the long-term average.

Eastern Dakotas (strata 45–49)
reported by biologist-pilot Terry Liddick

Habitat conditions in the eastern Dakotas crew area declined in a northerly direction. South Dakota was significantly improved from 2017 whereas North Dakota had moderately declined. Average to above-average fall and winter precipitation across much of South Dakota, along with several April snowstorms, provided significant moisture to fill temporary and seasonal wetlands. Average to below-average snowfall in North Dakota resulted in inadequate runoff to fill wetland basins despite a good frost seal. Many wetlands had low water levels or were dry.

In strata 48 and 49 in South Dakota, conditions were fair to good. Previously dry wetlands on the coteau contained water in 2018. Many semi-permanent wetland basins were full, as were most of the ephemeral wetlands north of Huron. Most wetlands were more the 50% full and all streams and rivers were well within their banks. Farming activities were just getting underway in May, delayed by April snowstorms. Production should be average or slightly above average in South Dakota.

Conditions deteriorated moving northward in strata 45 and 46 in North Dakota, with most of the state considered fair, except in the coteau region, which was considered good. This was a slight decline from 2017. Most seasonal wetlands in the drift plain were dry, but permanent coteau wetland basins were more than 50% full. The Souris and James Rivers were within their banks and Devil's Lake and Lake Sakakawea had little exposed beach areas due to the above-average snowfall in eastern Montana. There were few intact wetlands remaining in stratum 47 and most of the segments continued to be devoid of wetlands and waterfowl.

Overall, the coteau regions of both states were rated good, and should produce average numbers of waterfowl. South Dakota was much improved in 2018 while North Dakota declined. Stratum 47 in eastern North Dakota remained poor due to the extensive draining that has occurred.

In the eastern Dakotas, the 2018 May pond estimate was 32% lower than 2017 and 27% below the long-term average. The total duck estimate was similar to that of last year and was 33% above the long-term average. Mallard numbers were similar to 2017 and 42% higher than the long-term average. The gadwall estimate was 37% below the 2017 estimate and similar to the long-term average. American wigeon, blue-winged teal, and green-winged teal were similar to their 2017 estimates and 134%, 28%, and 183% higher than their long-term averages, respectively. Northern shovelers were 36% above the 2017 estimate and 64% above their long-term average. Northern pintail numbers were similar to 2017 but 25% below the long-term average. Redheads and canvasbacks were similar to last year's estimates and their long-term averages. Scaup numbers were similar to last year but were 138% above their long-term average.

Northern Saskatchewan, northern Manitoba, and western Ontario (strata 21–25, 50)
reported by biologist-pilots Walt Rhodes and Jim Wortham

Northern Saskatchewan and northern Manitoba (strata 21–25) experienced an average fall and winter and extremely cold temperatures from late winter into spring 2018. Precipitation was average to above average, with most coming during fall and winter. Temperatures were average during September 2017 through January 2018, with a cold snap in November 2017. Temperatures were more than 4°C below normal from February until early May 2018. There was

average fall and winter precipitation, whereas average to above-average spring precipitation occurred in north-central Saskatchewan from Prince Albert through Stony Rapids. Spring precipitation was well-below average near Buffalo Narrows, SK, and Fort McMurray, AB, and only slightly-below average in Manitoba from Flin Flon and Lynn Lake eastward through Gillam. Locals had predicted an extremely late spring due to the below-average temperatures, but extremely high temperatures in May 2018 rapidly melted ice, and phenology appeared only slightly delayed. Boreal wetlands remained adequately full of water but lower than in 2017, especially in northern Manitoba where streams and rivers had been outside of their banks a year earlier. The Parklands continued to exhibit wetland basins flooded beyond historic margins though water levels had fallen. Overall, good habitat conditions were expected across the crew area.

It was a late spring in western Ontario (stratum 50). Winter was characterized by cold temperatures and below-average snowfall. Normal snowfall amounts were not recorded until March and April. Thaw did not occur until well into May, with the areas near Kenora and Dryden thawing first. A rapid melt led to most lakes becoming ice-free by the third week of May. Healthy beaver populations persisted but water levels remained low due to lack of runoff from below-average snowfall. Most of western Ontario was only judged as good due to a late spring and lower-than-normal water levels.

The 2018 total duck estimate in this survey area was 24% above the 2017 estimate and similar to the long-term average. Mallard, redhead, and canvasback estimates were similar to last year and the long-term averages. Gadwall numbers were similar to 2017 and 70% below the long-term average. The American wigeon estimate was 107% above the 2017 estimate and 35% lower than the long-term average. Green-winged teal were 38% above last year and similar to their long-term average. Blue-winged teal numbers were similar to the 2017 estimate and 69% lower than the long-term average. Northern shovelers, northern pintails, scaup estimates were similar to last year and were 42%, 39%, and 50% below their long-term averages, respectively.

Central and northern Alberta, northeastern British Columbia, and Northwest Territories (strata 13–18, 20, 77)
reported by biologist-pilot Brian Lubinski

Ice-out was delayed throughout most of the crew area, but ice quickly disappeared once thawing began and birds migrated north at a pace that disappointed local spring hunters. Good-to-excellent habitat conditions were observed in 2018. The Peace-Athabaska (stratum 20) and Mackenzie River deltas (stratum 13) were considered in excellent condition. Good-to-excellent habitat conditions throughout northern Alberta persisted even though this area experienced extensive periods of warm temperatures, strong, dry winds, and scattered thunderstorm activity during much of May. These extreme wildfire conditions produced the first Province-wide fire ban over the Victoria Day weekend (May 19–21) in Alberta history. Generally there was an abundance of water on the landscape and ice cover was absent, except within the northernmost two transects of stratum 14, and on the largest, deepest lakes within the crew area (e.g., Lesser Slave, Great Slave, Willow, Lac La Martre, Tunago, Simpson, Tadenet, Lac Belot). Overall, habitat conditions throughout the region were considered good to excellent.

In this survey area, the total duck estimate for 2018 was 13% lower than the 2017 estimate but 33% higher than the long-term average. Mallard and American wigeon numbers were similar to their 2017 estimates and 36% and 42% above their long-term averages, respectively. Gadwall were similar to the 2017 estimate and their long-term average. Both green-winged teal and blue-winged teal were similar to their 2017 estimates, and 79% and 73% above their long-term averages. Northern shovelers were 29% below the 2017 estimate but 71% above the long-term average. The Northern pintail estimate was 26% below 2017 and 34% higher than the long-term average. Redhead numbers were similar to the 2017 estimate and 92% above the long-term average. Canvasbacks were similar to last year and the long-term average. The scaup estimate was similar to last year and 22% below its long-term average.

Alaska, Yukon Territory, and Old Crow Flats (strata 1–12)
reported by biologist Debbie Groves

Spring phenology in Alaska and the Old Crow Flats was generally average in 2018. River breakup dates were near their long-term averages (1980–2017) in most areas, except in southwestern Alaska (stratum 9) where breakup occurred a few days early. The ice-melt phenology of lakes and ponds was slightly early in stratum 9 and about normal elsewhere. Snowfall was above average this past winter in the central-interior, western, and southwestern parts of Alaska, which resulted in a higher-than-normal volume of spring meltwater runoff and subsequent minor flooding along some rivers and streams. Lakes and ponds throughout the crew area were at or near full capacity at the time of the survey. Habitat conditions in all strata appeared to be good for duck production in 2018.

The 2018 total duck estimate in this survey area was 15% below the 2017 estimate and 9% below the long-term average. Mallard, American wigeon, and canvasback numbers were similar to last year and the long-term averages. The green-winged teal estimate declined 27% relative to 2017 and was similar to the long-term average. Northern pintails were similar to their 2017 estimate but 29% below the long-term average. The northern shoveler estimate was similar to the 2017 estimate and 23% higher than the long-term average. Gadwall, blue-winged teal, and redheads are uncommon in this crew area.

Eastern survey area (strata 51–72)
reported by biologist-pilots Stephen Earsom, Mark Koneff, and Jim Wortham

The majority of southern Ontario and southern Quebec experienced average precipitation (85–115%), with several slightly below-average periods (60–85%), between 1 November 2017 and 31 March 2018. April 2018 was wetter than average but May was dry. The overall picture was somewhat drier than average. Snow and ice-melt timing was similar to last year in most areas and much later than last year in the higher-elevation regions of stratum 68. Most streams, beaver ponds, and string bogs across Ontario and Quebec had adequate water during the survey. Many permanent lakes were down a few inches and water levels on reservoirs were mostly below shoreline trees. We began the survey at the same time as last year despite the known ice cover in stratum 68, anticipating that weather delays would eventually allow phenology to catch up. Tree leaf-out was well underway when we began surveys on 9 May in stratum 53. A small amount of ice was observed on Georgian Bay but not in other areas of the Great Lakes. Many tree species were leafing out in both in strata 52 and 53 and in lower elevation areas of stratum 56, but not so much as to preclude observation of waterfowl. With good survey weather and no mechanical issues, we flew fewer segments on several days to not get ahead of the phenology, and elected to take a rest day in stratum 51 to allow northern lines of stratum 68 more time to advance. In spite of these efforts, the two northeastern transects (13 and 14) in stratum 68 were still not ready when flown on 23 May. Transect 14, especially, needed at least another week to thaw, which would have allowed migrating waterfowl to move through (higher than normal numbers of scoters were observed), and nesting waterfowl to complete pairing. These two high-elevation transects can be problematic due to cold, northwesterly systems coming off of James Bay. Other than these two transects, timing on other transects in stratum 68 and other strata was appropriate. Habitat was rated a mix of fair, good, and excellent, and should not be a widespread limiting factor for waterfowl production in 2018.

Spring arrived extremely late in northern Quebec (stratum 69). Snow cover and frozen wetlands remained into early June. Habitats between the James and Hudson Bays and Labrador were still 80% frozen during the first week of June with thawing only at lower elevations. Overall, the habitat conditions for breeding ducks were predicted to be poor with possible impacts on Canada goose production as well.

Winter 2017–2018 in the Maine and Atlantic Canada region started in late December with cold and snowy conditions. Temperatures moderated through February and early March 2018 but colder-than-normal temperatures returned for

late March and persisted through most of April, resulting in late ice break up in northern Maine and western New Brunswick. Warm temperatures in late April and early May resulted in rapid ice and snow melt that caused some flooding in Maine, and record flooding in the St. John River Valley in New Brunswick. Spring phenology in Maine and the Maritimes was about normal and even earlier-than-normal in Nova Scotia due to the rapid warm up. Habitat conditions were generally good, but poor conditions were recorded in drier areas of northwestern Maine and flooded areas of the St. John River, which likely destroyed many early nests. Winter was more tenacious across Newfoundland and Labrador. Despite cooler-than-average temperatures and some snow during the survey period, spring phenology was normal throughout most of Newfoundland. The substantial snowfall in the Gander area during the survey may have caused some nest abandonment. Despite the late snow and usual winter conditions that persisted in the higher elevations of the northern peninsula, production from Newfoundland should be good. Labrador exhibited mixed conditions. Eastern Labrador, and much of the higher terrain, remained locked in snow and ice during the survey, while areas in central and western Labrador were ice free. Ice-out was about 2 weeks over the region. Because of the late phenology, Labrador habitats were rated as fair to poor. In 2018, phenology extremes between the southern and northern strata of Maine and Atlantic Canada posed survey timing challenges, and staging aggregations of black ducks, scaup, and other species were observed in some southern strata, particularly on Prince Edward Island. It is also possible that increased counts for species like scaup and scoters in Labrador reflected the presence of migrating waterfowl, as well as a greater proportion of birds encountered in pre-breeding groups rather than territorial pairs.

The estimated abundance of mallards in the eastern survey area (1.1 ± 0.12 million) was similar to the 2017 estimate but 16% below the 1998–2017 average. Estimated abundance of American black ducks was 0.7 ± 0.07 million, which was 9% below last year's estimate of 0.8 ± 0.09 million, and 20% below the 1998–2017 average (Table 13). The 2018 goldeneye estimate was 0.5 ± 0.13 million, which was similar to the 2017 estimate but 17% below the 1998–2017 average. The green-winged teal estimate (0.3 ± 0.08 million) similar to its 2017 estimate and similar to its 1998–2017 average. The estimate of mergansers (0.7 ± 0.07 million) was similar to their 2017 and similar to the 1998–2017 average. Ring-necked ducks (0.6 ± 0.13 million) were similar to the 2017 estimate but 10% below the 1998–2017 average.

Other areas

Abundant precipitation two years ago buffered a general decline in breeding-waterfowl habitat conditions over most of the Pacific Flyway for 2017–2018 due to below-average winter and spring precipitation. California's habitat conditions remained good. Sufficient water resources existed in all areas during the survey, and 100% water allocations were forecast for all regions except the Klamath Basin. The 2018 California total duck estimate (549,200) was 39% above the 2017 estimate (393,700) and similar to the long-term average. The 2018 mallard estimate was similar to 2017 and the long-term average. Habitat conditions in Oregon deteriorated relative to last year, but remained fair to good in all surveyed areas because of above-average precipitation during 2016–2017. The 2018 Oregon total duck estimate was similar to 2017 and the long-term average. The 2018 mallard estimate increased 35% and was similar to the long-term average. According to biologists in Washington state, April was a wet month statewide, contributing to good pond conditions. The estimate for total ducks in Washington (281,100) was similar to the 2017 estimate (242,200) and 59% above the long-term average of 176,800. The mallard estimate in Washington was 124,900, which was unchanged from last year's estimate of 103,400, and 51% above the long-term average (82,800). British Columbia habitat conditions improved from 2017 to 2018. Below-average temperatures and higher-than-normal precipitation were recorded in British Columbia during winter 2017–2018. Above-average spring precipitation and temperatures

led to a rapid snow-melt and some flooding, especially areas affected by wildfires in 2017. In general, May 2018 habitat conditions were very good in the prime breeding-waterfowl areas in southern British Columbia and good in the northern Interior. The 2018 British Columbia total duck estimate was 346,300, which was similar to the 2017 estimate and to the long-term average (2006–2017). The 2018 mallard estimate (79,300) was similar to 2017 and the long-term average. Despite below-normal precipitation in most of Nevada, the survey area remained in excellent condition from residual waters. The mallard estimate in Nevada of 13,900 was 117% above the 2017 estimate and 85% above the long-term average.

The midwestestern U.S. had average to above-average fall and winter precipitation and slightly- to well-below normal early-spring temperatures. Minnesota wetland conditions were similar to 2017. The number of permanent or semi-permanent wetlands was 1% below the 2017 estimate and 4% above the long-term average. In Minnesota, April was the third coldest and May was one of the warmest. Ice-out was as much as 2–4 weeks later than average. The Minnesota total duck population, excluding scaup, was 692,600, 9% above last year's index of 636,000, and 12% above the long-term average (1968–2017) of 620,000. The 2018 estimated mallard breeding population (295,400) was similar to 2017 (213,600) and the long-term average (227,900). Michigan habitat conditions were similar to 2017 and slightly above the long-term average. Michigan total duck estimate (452,400) was 34% below the 2017 estimate and 28% below the long-term average. The breeding mallard estimate was similar to 2017 and 27% below the long-term average. Wisconsin also experienced a very cold April 2018 followed by a rapid warmup in May. Fall and winter precipitation was slightly above average statewide while spring precipitation was slightly below average (3%). Usual high-density duck nesting areas in southern and eastern Wisconsin had normal or above-normal water conditions. The 2018 Wisconsin total breeding duck estimate was similar to 2017 and the long-term average. The mallard breeding population estimate, was similar to 2017 and the long-term average.

Atlantic Flyway Breeding Waterfowl survey states experienced a generally cold winter 2017–2018. Drought conditions in the northeast were alleviated by multiple large snow events and early spring rains. Some states reported heavy spring rains and flooding that was expected to produce localized reduced waterfowl nesting. Slightly later spring phenology was recorded but normal to slightly-delayed waterfowl nesting was observed. The total duck estimate from the 2018 Atlantic Flyway Breeding Waterfowl survey was 1.4 million, which was similar to the 2017 estimate of 1.3 million and similar to the long-term (1993–2017) average of 1.4 million. Mallard numbers (482,100) were similar to the 2017 estimate of 448,500 and 32% below the long-term average of 709,000.

Mallard Fall-flight Index

The mid-continent mallard population is composed of mallards from the traditional survey area (revised in 2008 to exclude mallards from Alaska and the Old Crow Flat area of the Yukon Territory), Michigan, Minnesota, and Wisconsin, and was estimated to be 11.4 ± 1.1 million birds in 2018 (Figure 5). This was similar to the 2017 estimate of 12.9 ± 1.2 million.

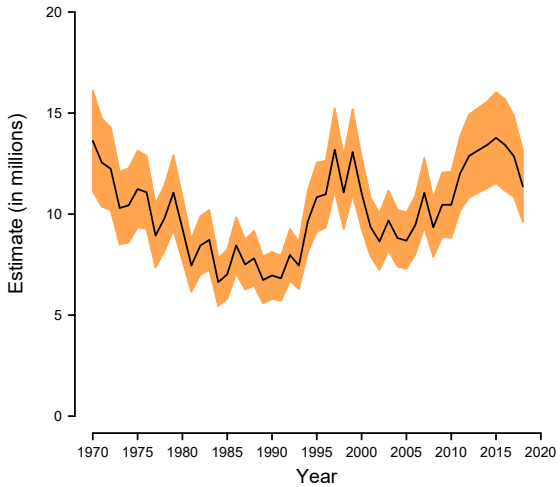

Figure 5. Estimates and 90% confidence intervals for the predicted size of the mallard population in the fall.

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Status of Geese and Swans

This section summarizes information regarding the status and productivity of goose and swan populations in North America. Information was compiled from a broad geographic area and is provided to assist managers in regulating harvest. Most populations of geese and swans in North America nest in the Arctic and Subarctic regions of Alaska and northern Canada (Figure 6), but several Canada goose populations nest in temperate regions of the United States and southern Canada ("temperate-nesting" populations). Arctic-nesting geese rely predominantly on stored reserves for egg production. Thus, persistent snow cover reduces nest site availability, delays nesting activity, and often results in depressed reproductive effort and productivity. In general, goose productivity will be above average if nesting begins by late May in western and central portions of the Arctic and by early June in the eastern Arctic. Production usually is poor if nest initiation is delayed much beyond 15 June. For temperate-nesting Canada goose populations, productivity is generally less variable among years, but recruitment can be affected by local factors such as drought or weather events.

Methods

We have used common nomenclature for various goose and swan populations, but they may differ from other published information. Species nomenclature follows the List of Migratory Birds in Title 50 of the Code of Federal Regulations, Section 10.13, revised 1 November 2013 (78 FR 65844). Some of the goose populations described herein are composed of more than one subspecies, and some light goose populations contain two species (i.e., snow and Ross's geese). Population estimates for geese (Appendices D.1, D.2, and D.3) are derived from a variety of surveys conducted by biologists from federal, state, and provincial agencies, or from universities (Appendices A.2). Surveys include the Waterfowl Breeding Population and Habitat Survey (WBPHS, see Status of Ducks section of this report), the Midwinter Survey (conducted each December or January in wintering areas), the Yukon–Kuskokwim Delta (YKD) Coastal Zone Survey, the Arctic Coastal Plain (ACP) Survey, and surveys that are specifically designed for various goose populations. Where survey methodology allowed, 95% confidence intervals are presented in parentheses following population estimates. Trends of population estimates were calculated by regressing the natural logarithms of survey results on year, and slope coefficients were presented and tested for equality to zero (t-statistic). Changes in population indices between the most recent and previous year were calculated and, where possible, assessed with a two-tailed z-test using the sum of sampling variances for the two estimates. All statistical tests and analyses were conducted using an alpha level of 0.05. Primary abundance indices used as management plan population objectives are described first in population sections, graphed, and included in appendices. Information was the best available at the time of finalizing this report but can differ from final estimates or observed conditions. Habitat and breeding conditions were primarily based on observations made during various waterfowl surveys and information from field biologists. These reports provide reliable information for specific locations, but may not provide an accurate assessment over vast geographic ranges.

Results and Discussion

Conditions in the Arctic and Subarctic

Production of Arctic-nesting geese depends heavily upon the annual timing of snow and ice melt. In 2018, spring phenology was earlier

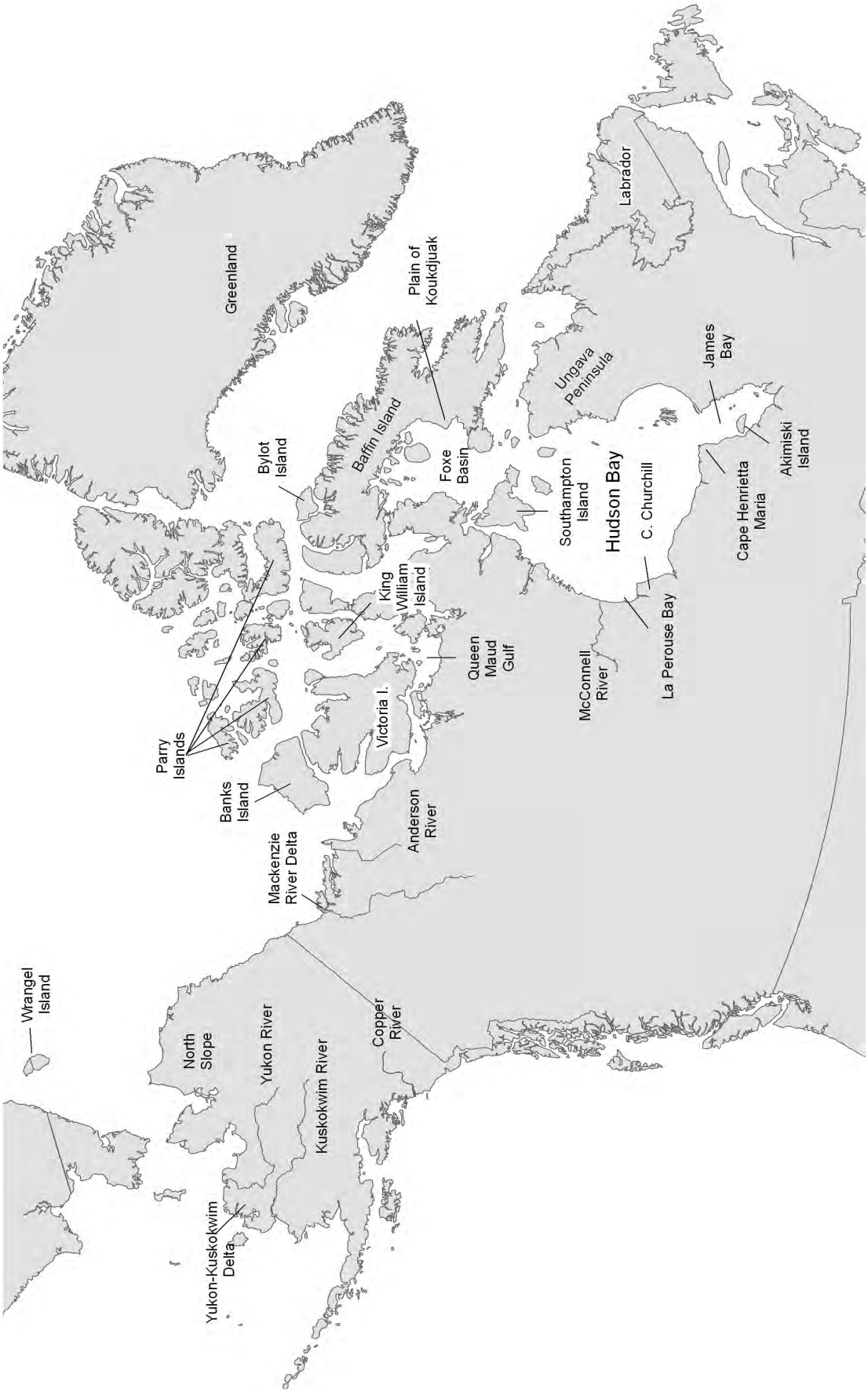


Figure 6. Important goose and swan nesting areas in Arctic and Subarctic North America.

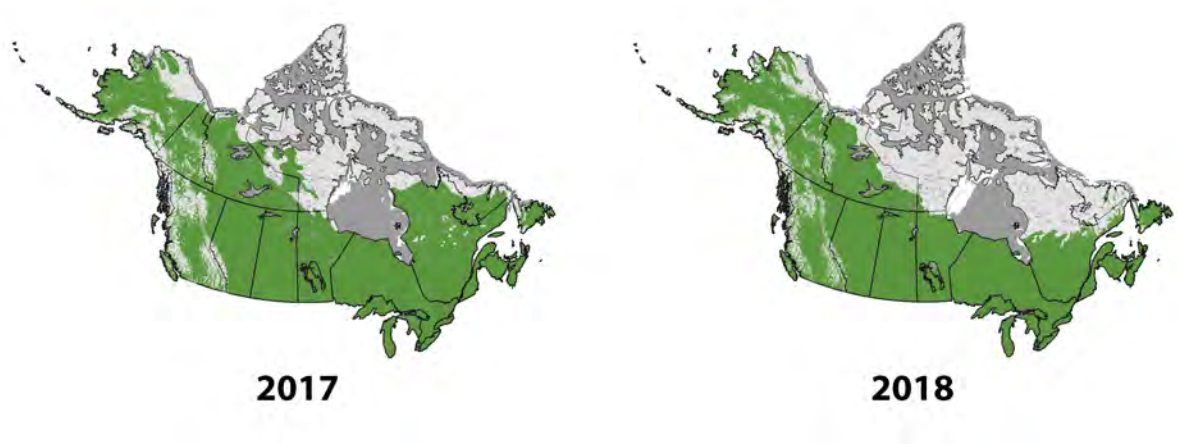


Figure 7. The extent of snow (light gray) and ice (dark gray) cover in North America on 2 June 2017 and 2 June 2018 (National Ice Center 2018).

than average in southwestern Alaska and later than average across most areas in northern Alaska and the western, central, and eastern Arctic and Subarctic. The snow and ice cover graphics (Figure 7) illustrate that ice or snow cover on 2 June 2018 compared to the same date in 2017 was generally similar in Alaska and more extensive throughout the Arctic and Subarctic (National Ice Center 2018). Based on this information, above-average or average breeding conditions were expected for goose and swan populations in southern Alaska and below-average or average breeding conditions were expected for most other areas.

Conditions in Southern Canada and the United States

Conditions that influence the productivity of Canada geese vary less from year to year in temperate regions than in the Arctic and Subarctic. Given adequate wetland numbers and the absence of flooding, temperate-nesting Canada geese are reliably productive. Many temperate-nesting goose populations remain above management objective levels, despite efforts to reduce abundance. In 2018, habitat conditions in the Pacific Flyway were variable, with above-average winter and spring precipitation in some areas of British Columbia, Washington, Idaho, and Montana but below-average precipitation in most other states, particularly late in the spring. Within the Central Flyway, habitat conditions in much of the Canadian prairies, North Dakota, and South Dakota were good or fair, except for poor conditions in the southernmost portions of Saskatchewan and Manitoba and easternmost portions of these states. Average or below-average breeding conditions were reported in other Central Flyway states. Mississippi Flyway biologists generally reported average or above-average breeding conditions, and habitat conditions in southern Ontario were good. In the Atlantic Flyway, late snowstorms and cold temperatures resulted in frozen wetlands into April in some areas, and biologists reported average or slightly delayed waterfowl nesting in most areas. Habitat conditions in Canadian Maritime provinces were mostly good or fair, although portions of Newfoundland and Labrador were poor due to late spring phenology.

Status of Canada Geese

North Atlantic Population (NAP)

NAP Canada geese principally nest in Newfoundland and Labrador. They commingle during winter with other Atlantic Flyway Canada goose populations, although NAP geese have a more coastal distribution than other populations (Figure 8). In 2016, biologists revised the index used to monitor this population to a composite

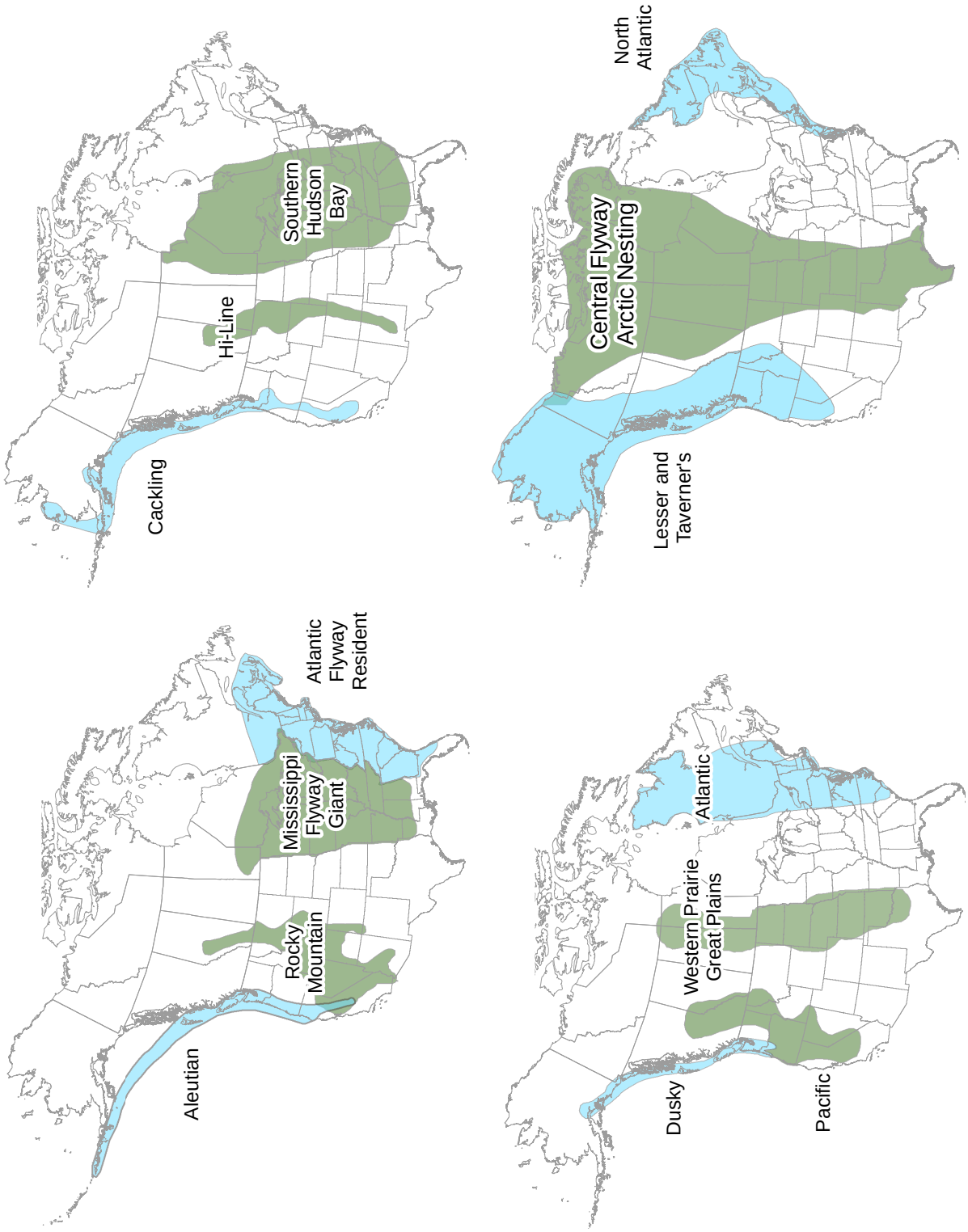


Figure 8. Approximate ranges of Canada goose populations in North America.

Table 14. Canada goose indices (in thousands) from primary monitoring surveys.

	Estimate/Count		Change from 2017		10-year Trend	
Population	2018	2017	%	*P*	%/yr[a]	*P*
North Atlantic	54	48	+12	0.648	0	0.565
Atlantic	112	161	−30	0.018	−4	0.091
Atlantic Flyway Resident	1,031	933	+10	0.380	0	0.980
Southern Hudson Bay[b]	–	72	–	–	–	–
Mississippi Flyway Giant	–	1,776	–	–	–	–
Western Prairie and Great Plains	1,350	1,353	0	0.980	+2	0.038
Central Flyway Arctic Nesting[c]	2,562	1,892	+35	0.262	−3	0.424
Hi-Line	409	375	+9	0.477	+4	0.084
Rocky Mountain	253	188	+35	0.107	+8	0.007
Pacific	351	298	+18	0.297	+4	0.033
Dusky	11	14	−20	0.095	+5	0.101
Cackling	204	290	−30	<0.001	+2	0.434
Lesser	2	3	−28	0.590	−9	0.068
Taverner's	46	46	0	0.982	0	0.898
Aleutian	171	169	+2	0.915	+8	0.002

[a] Rounded values mask change in estimates.
[b] Estimates of the mainland survey area only; Akimiski Island estimates are not included.
[c] Years presented refer to year–2.

estimate that combines data from both the Canadian Wildlife Service (CWS) helicopter plot survey and the WBPHS (strata 66, 67, and 70; Figure 9). The new composite time series is updated annually due to the estimation procedure. Estimates presented are mean and 2.5% and 97.5% Bayesian credible intervals. In 2018, the composite estimate of total indicated pairs was 53,800 (38,800–73,800), similar to the 2017 estimate of 48,200 (34,900–66,600; $P = 0.648$). During the past 10 years, these estimates did not have a significant trend ($P = 0.565$). Habitat conditions in 2018 were generally poor in Labrador due to late spring phenology but good in most areas of Newfoundland.

Atlantic Population (AP)

AP Canada geese nest throughout much of Quebec, especially along Ungava Bay, the eastern shore of Hudson Bay, and on the Ungava Peninsula. This population winters from New England to South Carolina, but the largest concentrations occur on the Delmarva Peninsula (Figure 8). This population is monitored by a spring survey of the Ungava Peninsula in northern Quebec (Atlantic Flyway Council 2008). The breeding pair estimate was 112,200 (90,000–134,500), which was 30% less than last year's estimate of 161,100 (127,300–194,900; $P = 0.018$; Figure 9). The total population estimate (breeding pairs and grouped birds) was 738,800 (588,500–889,100), similar to the 2017 estimate of 705,900 (562,600–849,300; $P = 0.756$). During the past 10 years, breeding pair estimates have not shown a significant trend ($P = 0.091$), but total population estimates have decreased 5% per year ($P = 0.010$). The total population estimate may contain large numbers of non-AP geese that have migrated there to molt and should be interpreted cautiously. Spring phenology was much later than average in northern and central Quebec, and habitat conditions appeared below average for nesting. Snow cover persisted and most lakes and ponds remained frozen into mid-June. A low proportion of single geese observed during the spring survey usually forecasts below-average production, and the proportion of indicated pairs observed as single geese was 38% in 2018, which was less than the long-term average of

52% (1993–2018; range = 34–69%). A model that uses May temperatures and June snowfall also forecasted very poor production (J. Stiller, NY Department of Environmental Conservation, unpublished data).

Atlantic Flyway Resident Population (AFRP)

AFRP Canada geese were introduced and established throughout the Atlantic Flyway during the early 20^{th} century and are composed of various subspecies. This population of large Canada geese inhabits all states of the Atlantic Flyway and southern portions of Quebec and the Maritime provinces (Figure 8). The breeding population is estimated during the spring via the Atlantic Flyway Breeding Waterfowl Plot Survey (Atlantic Flyway Council 1999). A breeding population of 1,030,900 (867,900–1,193,900) AFRP Canada geese was estimated during the spring of 2018, similar to the 2017 estimate of 933,300 (788,300–1,078,300; $P = 0.380$; Figure 9). The 10-year trend for these estimates was not significant ($P = 0.980$). Northeastern and mid-Atlantic provinces and states experienced a generally cold winter, with high levels of precipitation during winter and spring. Late snowstorms and cold temperatures resulted in frozen wetlands into April in some areas, and biologists reported average or slightly delayed waterfowl nesting in most areas.

Southern Hudson Bay Population (SHBP)

SHBP Canada geese nest in the Hudson Bay Lowlands, on Akimiski Island, and along the eastern and southern portions of Hudson and James Bays, and they concentrate during fall and winter throughout Manitoba, Ontario, and the Mississippi Flyway states (Figure 8). SHBP Canada geese are comprised of the former Southern James Bay, Mississippi Valley, and Eastern Prairie Populations of Canada geese. In 2016 a new aerial survey was developed to monitor SHBP Canada geese along the south and west coastal areas of the Hudson and James Bays (Mississippi Flyway Council 2017). Estimates for 2018 were not available when this report was published. The 2017 estimate of SHBP Canada geese on the mainland portion of the survey area was 71,600, 10% greater than the 2016 estimate of 65,100. In 2018, spring phenology along the western Hudson and James Bays was later than average, and biologists observed very poor productivity in many areas within this population's breeding range.

Mississippi Flyway Giant Population (MFGP)

MFGP Canada geese nest in the Mississippi Flyway states and in southern Ontario and southern Manitoba. Giant Canada geese were reestablished or introduced in all Mississippi Flyway states (Figure 8), and they now represent a large proportion of all Canada geese in the Mississippi Flyway. The total population is estimated during spring surveys within the Mississippi Flyway states and provinces (Mississippi Flyway Council 2017). Estimates for 2018 were not available when this report was published. In 2017, biologists counted 1,776,000 MFGP geese, 16% greater than the 2016 count of 1,528,800 (Figure 9). There was no significant trend in these indices during the most recent 10-year period ($P = 0.275$). In 2018, habitat conditions were good in southern Ontario, poor or fair in southern Manitoba, and generally average or above average across most Mississippi Flyway states.

Western Prairie and Great Plains Populations (WPP/GPP)

WPP Canada geese nest in eastern Saskatchewan and western Manitoba. GPP Canada geese are composed of large Canada geese resulting from restoration efforts in Saskatchewan, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. These two populations are managed jointly. Geese from these breeding populations commingle during migration and winter with Canada geese from other populations (Figure 8). The WBPHS (strata 21–25, 31, 34–40, 43–49) and Midwinter Survey provide indices of this population within its primary breeding and wintering ranges, respectively. In 2018, the estimated spring population was 1,349,700 (1,182,800–1,516,700),

similar to last year's estimate of 1,352,800 (1,186,600–1,519,000; $P = 0.980$; Figure 9). The WBPHS estimates have increased 2% per year since 2009 ($P = 0.038$). During the 2018 Midwinter Survey, 577,200 WPP/GPP geese were counted, 5% less than the 608,700 recorded in 2017. Midwinter Survey indices have not shown a significant trend from 2009 to 2018 ($P = 0.834$). Habitat conditions in southern Manitoba, southern Saskatchewan, North Dakota, and South Dakota were generally good to fair, except for poor conditions in the southernmost portions of these provinces and easternmost portions of these states.

Central Flyway Arctic Nesting Canada Geese (CFAN)

CFAN were previously managed separately as the Short Grass Prairie (SGP) and Tall Grass Prairie (TGP) populations of Canada geese, which are now referred to as West-tier and East-tier CFAN, respectively (Central and Mississippi Flyway Councils 2013). East-tier CFAN nest on Baffin (particularly on the Great Plain of the Koukdjuak), Southampton, and King William Islands; north of the Maguse and McConnell Rivers on the Hudson Bay coast; and in the eastern Queen Maud Gulf region. East-tier CFAN winter mainly in Oklahoma, Texas, and northeastern Mexico. West-tier CFAN nest on Victoria and Jenny Lind Islands and on the mainland from the Queen Maud Gulf west and south to the Mackenzie River. These geese winter in southeastern Colorado, northeastern New Mexico, and the Oklahoma and Texas panhandles (Figure 8). Alternative nomenclature and delineation is used by the Mississippi Flyway, the Canadian Wildlife Service, and others in reference to the subspecies *Branta hutchinsii hutchinsii*. In those documents, those geese are referred to as Mid-continent cackling geese and defined as geese breeding north of the tree line in Canada. Lincoln estimates of the adult cohort are the primary management indices for this population. Lincoln estimates are derived from annual estimates of total harvest and harvest rate and represent an indirect measure of abundance. Due to the methodology, Lincoln estimates are typically not available from the most recent years. The 2016 adult Lincoln estimate was 2,562,400 (1,565,400–3,559,300), which was similar to the 2015 estimate of 1,892,000 (1,274,600–2,509,400; $P = 0.262$). During the past 10 years, there was no significant trend in these estimates ($P = 0.424$; Figure 9). The Midwinter Survey provides an index of CFAN within their winter range of the Central Flyway. In 2018, 936,100 CFAN were counted during the Midwinter Survey, 35% greater than the 2017 index of 691,000. Over the past 10 years, Midwinter Survey counts have not shown a significant trend ($P = 0.213$). A portion of the West-tier CFAN breeding range is covered by the WBPHS in the Northwest Territories (strata 13–18). In 2018, the WBPHS estimate was 165,400 (119,500–211,300), similar to last year's estimate of 152,600 (104,400–200,900; $P = 0.707$). There was no significant trend in these estimates from 2009 to 2018 ($P = 0.979$). In 2018, conditions were generally below average or average across most areas within the breeding range of this population.

Hi-line Population (HLP)

HLP Canada geese nest in southeastern Alberta, southwestern Saskatchewan, eastern Montana and Wyoming, and Colorado. This population winters in these states and New Mexico (Figure 8). A breeding index of HLP geese is based on the WBPHS estimates from portions of Alberta (strata 26–29), Saskatchewan (strata 30, 32, 33), and Montana (strata 41–42). A winter index of HLP geese is based on Midwinter Survey counts in portions of Montana, Wyoming, Colorado, New Mexico, Nebraska, Alberta, and Saskatchewan (Central Flyway Council 2010). The 2018 WBPHS estimate for HLP geese was 409,200 (343,700–474,800), similar to last year's estimate of 374,600 (305,100–444,1000; $P = 0.477$; Figure 9). There was no significant trend in these indices during 2009–2018 ($P = 0.084$). The 2018 Midwinter Survey index for HLP geese was 505,800, 76% greater than last year's count of 286,800. Over the past 10 years, Midwinter Survey indices have not shown a significant trend ($P = 0.078$). Habitat conditions

in southern Alberta and western Montana were excellent or good and improved from last year, whereas fair or poor conditions were observed in many areas of southern Saskatchewan and eastern Montana.

Rocky Mountain Population (RMP)

RMP Canada geese nest in southern Alberta and western Montana, and the inter-mountain regions of Utah, Idaho, eastern Nevada, Wyoming, and Colorado. This population winters mainly in central and southern California, Arizona, Nevada, Utah, Idaho, and Montana (Figure 8). An index of breeding RMP geese is based on WBPHS estimates from portions of strata 26–29 in Alberta and strata 41–42 in Montana (Pacific Flyway Council 2000*b*). In 2018, the WBPHS estimate for RMP geese was 252,700 (188,600–316,800), similar to last year's estimate of 187,700 (141,200–234,200; $P = 0.107$; Figure 9). The WBPHS estimates for RMP geese increased 8% per year during the past ten years ($P = 0.007$). Habitat conditions in most areas within the range of this population were good or excellent and improved from last year, although some areas experienced below-average late-season precipitation.

Pacific Population (PP)

PP Canada geese nest and winter west of the Rocky Mountains from northern Alberta and British Columbia to California (Figure 8). An index of breeding PP geese is based on WBPHS estimates from strata 76–77 in Alberta and the standardized surveys in British Columbia, Washington, Oregon, and California (Pacific Flyway Council 2000*a*). The PP goose estimate in 2018 was 350,700 (270,600–430,800), similar to the 297,900 (239,300–356,600; $P = 0.297$) reported in 2017 (Figure 9). These indices increased 4% per year since 2010 ($P = 0.033$). In 2018, habitat conditions were variable within the range of PP Canada geese, with many areas experiencing either above-average or below-average winter and spring precipitation.

Dusky Canada Geese

Dusky Canada geese nest on the Copper River Delta of southcentral Alaska and winter in the Willamette and Lower Columbia River Valleys of Oregon and Washington (Figure 8). Dusky Canada geese are surveyed on their breeding grounds on the Copper River Delta and Middleton Island, Alaska (Pacific Flyway Council 2015). In 2018, the Dusky Canada goose population index was 10,800 (9,100–12,600), which was similar to the 2017 estimate of 13,500 (10,900–16,100; $P = 0.095$; Figure 9). During the past 10 years, these estimates have not shown a significant trend ($P = 0.101$). In 2018, the Copper River Delta experienced a warm and early spring, and the survey, which is timed to coincide with goose incubation, was conducted about 2 days earlier than the long-term average (15 May; 1986–2017).

Cackling Canada Geese

Cackling Canada geese nest on the YKD of western Alaska and primarily winter in the Willamette and Lower Columbia River Valleys of Oregon and Washington (Figure 8). The total fall population is estimated from counts of adults during the YKD Coastal Zone Survey during the spring, expanded by a ratio derived from neck-collared individuals observed in the fall and winter (Pacific Flyway Council 2016*a*). The 2018 fall estimate was 203,700 (178,300–229,100), which was 30% less than last year's estimate of 289,900 (253,300–326,500; $P \leq 0.001$). Over the 2009–2018 time series, no significant trend was observed ($P = 0.434$; Figure 9). Early spring phenology was observed on the YKD in 2018, similar to recent years, and the YKD Coastal Zone Survey was conducted on the earliest start date in history. Ice breakup on the Kuskokwim River was 2 May, about 8 days earlier than the long-term average (1985–2018).

Lesser and Taverner's Canada Geese

Lesser and Taverner's Canada geese nest throughout Alaska and winter in Washington, Oregon, and California (Figure 8). Nesting Taverner's geese are more associated with tundra

areas of the North Slope and western Alaska, whereas lesser Canada geese nest in Alaska's interior and south-central regions. Population indices for lesser Canada geese are based on WBPHS estimates in stratum 1 (Kenai-Susitna), stratum 2 (Nelchina), stratum 3 (Tanana-Kuskokwim), stratum 4 (Yukon Flats), and stratum 12 (Old Crow Flats). The 2018 lesser Canada goose indicated total bird index was 2,000 (700–3,400), similar to the 2017 index of 2,800 (200–5,400; $P = 0.590$; Figure 9). These indices did not have a significant trend from 2009 to 2018 ($P = 0.068$). Population indices for Taverner's Canada geese are derived from three breeding survey efforts: the Arctic Coastal Plain Survey, the YKD Coastal Zone Survey, and the WBPHS (stratum 9 [inland portions of the YKD], stratum 10 [Seward Peninsula], and stratum 11 [Kotzebue Sound]). The 2018 Taverner's goose indicated total bird index was 45,900 (32,100–59,700), which was similar to the 2017 index of 45,700 (32,400–59,000; $P = 0.982$; Figure 9). These indices did not have a significant trend during the past 10 years ($P = 0.898$). In 2018, spring phenology in Alaska was early in southwestern areas and later than average in northern areas, with generally good habitat conditions across most areas of the state.

Aleutian Canada Geese

Aleutian Canada geese nest primarily on the Aleutian Islands and winter along the Pacific Coast as far south as central California (Figure 8). The Aleutian Canada goose was listed as endangered under the Endangered Species Act (ESA) in 1967 when abundance was less than 1,000 individuals. As abundance increased, it was downgraded to threatened in 1990 and removed from protection under the ESA in 2001. The total Aleutian Canada goose population during the fall and winter is estimated from mark-resight observations of neck-banded geese (Pacific Flyway Council 2006*a*). The population estimate in 2018 was 171,300 (139,500–203,100), similar to the 2017 estimate of 168,500 (128,700–208,400; $P = 0.915$; Figure 9). These estimates have increased 8% per year since 2009 ($P = 0.002$). Spring phenology was advanced and breeding conditions were above average or average on the Alaska Peninsula and Aleutian Islands.

Status of Light Geese

The term light geese collectively refers to Ross's geese (*Chen rossii*) and both the lesser (*C. caerulescens caerulescens*) and greater (*C. c. atlantica*) snow goose subspecies (including all hybrids and both white and blue color phases). There are three populations of lesser snow geese based on their breeding ranges (Wrangel Island, Western Arctic, and Mid-continent). Lesser snow geese and Ross's geese occur in many wintering areas together and are not typically differentiated during the Midwinter Survey, so we report indices of light geese from this survey.

Ross's Geese

Ross's geese nest primarily in the Queen Maud Gulf region, but increasing numbers are nesting in other areas of the central and eastern Arctic and along the western coast of Hudson Bay. Ross's geese primarily winter in California, New Mexico, Texas, and Mexico, with increasing numbers wintering in other portions of the Central and Mississippi Flyways (Figure 9). Ross's geese are annually surveyed at Karrak Lake in the Queen Maud Gulf region. Estimates from Karrak Lake are typically not available until after the publication of this report, so we present the previous year's estimate. The 2017 estimate of nesting Ross's geese at Karrak Lake was 446,600 (416,500–476,700), which was 28% less than the 2016 estimate of 624,100 (583,900–664,400; $P \leq 0.001$; Figure 10). These estimates decreased 4% per year during 2008–2017 ($P = 0.024$). In 2018, spring phenology at Karrak Lake was delayed, and ice breakup (13 June) and first observation of goslings (3 July) were later than the long-term averages (11 June and 30 June, respectively; 1998–2018). Later-than-average spring phenology was noted across most of the western and central Arctic.

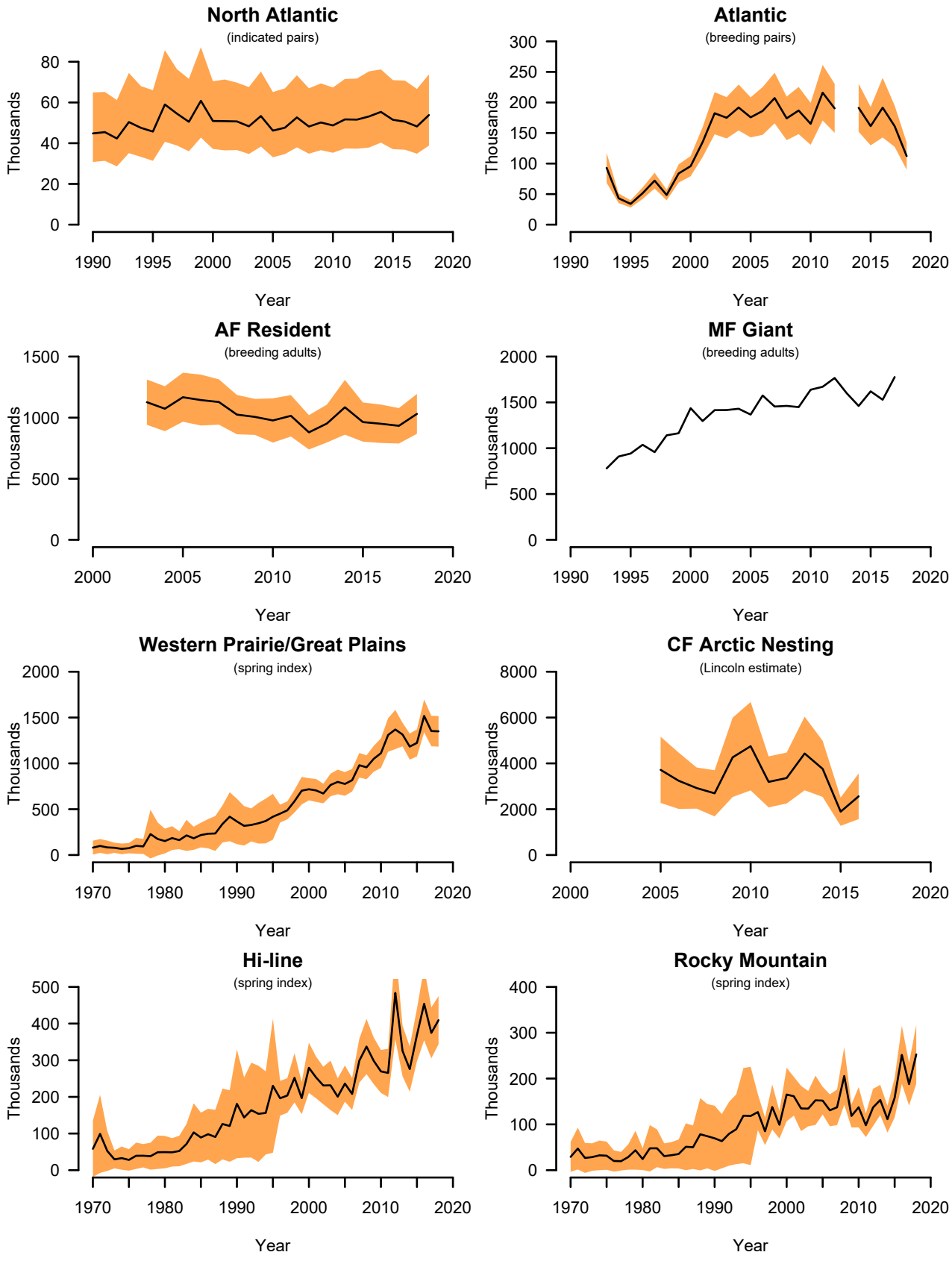
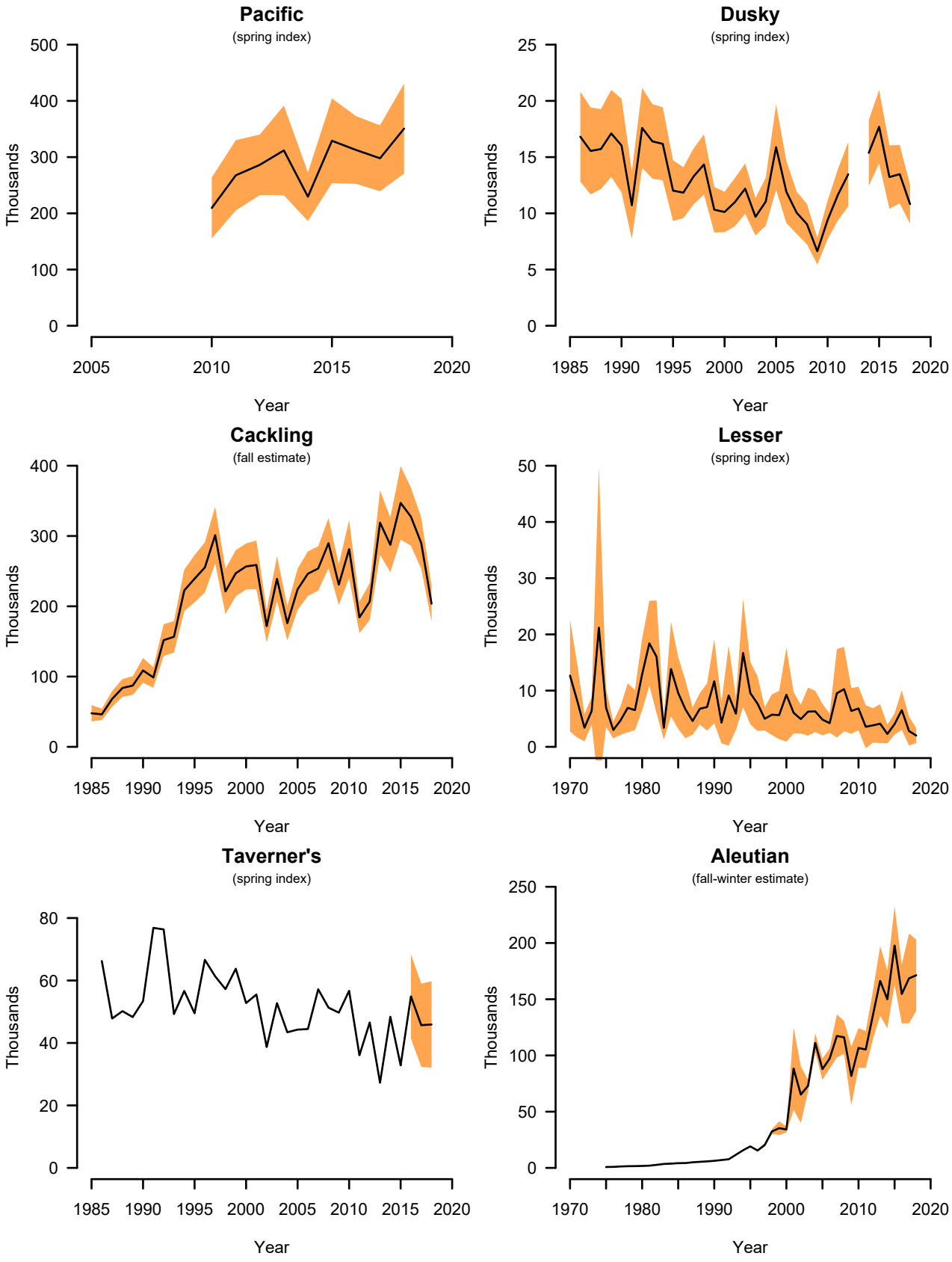


Figure 9. Estimated numbers (and 95% confidence intervals, where applicable) of Canada goose populations based on primary management surveys.


Pacific
(spring index)
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Taverner's
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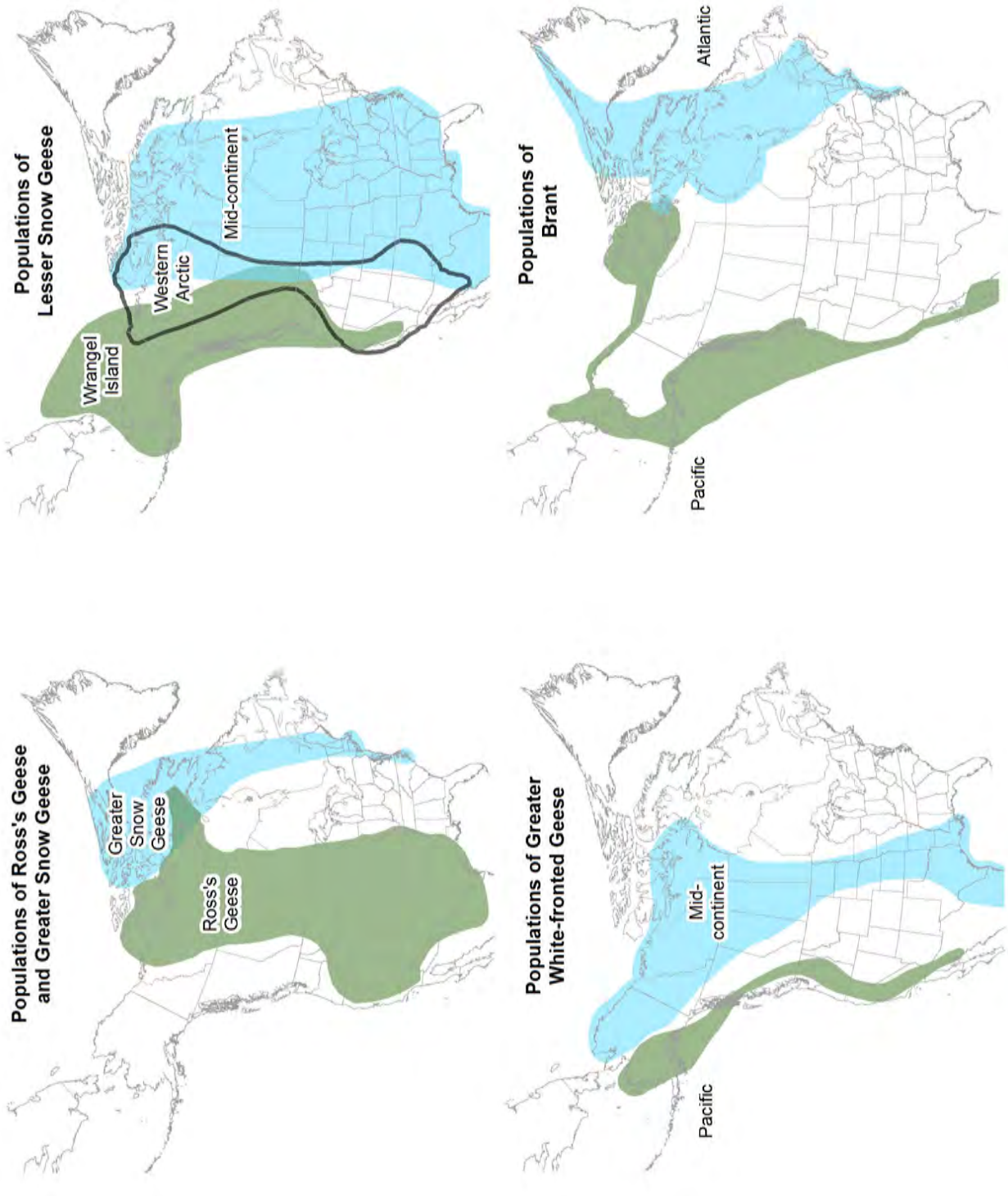

Figure 9. Approximate ranges of Ross's, snow, brant, and greater white-fronted goose populations in North America.

Table 15. Light goose (Ross's goose and lesser and greater snow goose) indices (in thousands) from primary monitoring surveys.

	Estimate/Count		Change from 2017		10-year Trend	
Population	2018	2017	%	*P*	%/yr	*P*
Ross's geese[a]	447	624	−28	<0.001	−4	0.024
Mid-continent Population lesser snow geese[b]	11,913	9,248	+29	0.156	−3	0.196
Pacific Flyway Population light geese	–	1,907	–	–	–	–
Wrangel Island Population lesser snow geese	306	346	−12	–	+11	<0.001
Greater snow geese	877	747	+17	0.035	−2	0.137

[a] Years presented refer to year–1.
[b] Years presented refer to year–2.

Mid-continent Population (MCP)

MCP lesser snow geese winter in the Central and Mississippi Flyways and nest primarily from Banks Island in the western Arctic to Baffin Island in the eastern Arctic (Figure 9). The management plan for MCP lesser snow geese was updated in 2018 and replaced prior management guidelines for MCP and Western Central Flyway Population (WCFP; wintering population) lesser snow geese (Mississippi Flyway Council 2018, Central Flyway Council 2018). Lincoln estimates of the adult cohort are now the primary management indices. The 2016 adult Lincoln estimate was 11,912,500 (9,062,900–14,762,000), similar to the 2015 estimate of 9,248,200 (6,917,100–11,579,300; $P = 0.156$). During the past 10 years, there was no significant trend in these estimates ($P = 0.196$; Figure 10). During the 2018 Midwinter Survey, biologists counted 311,300 light geese in southeastern Colorado, New Mexico, and the Texas Panhandle (winter range of WCFP), which was 45% greater than the 214,200 counted in 2017. Within the other portions of the Central and Mississippi Flyways, 4,061,200 light geese were counted in 2018, 19% greater than the 2017 index of 3,417,100. There was no significant trend in either of the Midwinter Survey indices during 2009–2018 ($P = 0.555$ and $P = 0.128$, respectively). In 2018, spring phenology was delayed and breeding conditions were generally below average across much of the western, central, and eastern Arctic and Subarctic.

Western Arctic (WA) and Wrangel Island (WI) Populations

Lesser snow geese in the Pacific Flyway originate from nesting colonies in the western and central Arctic and on Wrangel Island, Russia. WA lesser snow geese nest primarily on Banks Island, with smaller colonies in coastal areas of the Northwest Territories, and along the Alaskan Arctic Coastal Plain. WI lesser snow geese nest on Wrangel Island. WA and WI lesser snow geese mix during winter and also occur with MCP lesser snow geese and Ross's geese. WA lesser snow geese primarily winter in central and southern California, the western Central Flyway, and the northern highlands of Mexico. WI lesser snow geese principally winter in the Skagit-Fraser River Deltas in British Columbia and Washington and in northern and central California (Figure 9). Light geese in the Pacific Flyway (Pacific Flyway Population) are indexed by fall and winter surveys in California, Oregon, Washington and British Columbia. Not all estimates for 2018 were available when this report was published. The 2017 Pacific Flyway Population light goose count was 1,906,800, 59% greater than the prior count of 1,199,600. Pacific Flyway Population light goose indices increased 6% per year during 2008–2017 ($P = 0.026$). Breeding ground surveys are periodically conducted for WA (Pacific Flyway Council 2013)

and WI lesser snow geese (Pacific Flyway Council 2006*b*), and indirect estimates of population size for WA and WI lesser snow geese are reported in the "Population Status of Migratory Game Birds in Canada" annual report (Canadian Wildlife Service Waterfowl Committee 2017). A photographic breeding colony survey for WA lesser snow geese was last conducted in 2013 and recorded 419,800 lesser snow geese. The 2018 WI lesser snow goose estimate from the breeding ground survey on Wrangel Island was 306,000, 12% less than the 2017 estimate of 346,000 (Figure 10). These indices increased 11% per year since 2009 ($P \leq 0.001$). In 2018, the lesser snow goose total bird index from the Arctic Coastal Plain survey was 35,200 (33,000–37,400), which was similar to the 2017 estimate of 58,300 (16,400–100,1000; $P = 0.281$). These indices did not show a significant trend during the past 10 years ($P = 0.091$). Spring phenology was delayed across most areas in the western Arctic, northern Alaska, and on Wrangel Island.

Greater Snow Geese

Greater snow geese nest on Bylot, Axel Heiberg, Ellesmere, and Baffin Islands, and in Greenland, and winter along the Atlantic coast from New Jersey to North Carolina (Figure 9). This population is monitored on spring staging areas near the St. Lawrence Valley in Quebec by an annual aerial photographic survey (Atlantic Flyway Council 2009). The preliminary 2018 spring survey estimate was 877,000 (781,000–973,000), a 17% increase ($P = 0.035$) from the 2017 estimate of 747,000 (674,000–820,000; Figure 10). There was no significant trend in these estimates during the past 10 years ($P = 0.137$). Breeding conditions were below average on Bylot Island in 2018. Spring and nesting phenology were delayed due to thick winter snow pack and cool weather in June, and predation levels were high during egg laying due to decreased lemming abundance. Nest initiation date (14 June) and first hatching date (11 July) were later than long-term averages (12 June and 9 July, respectively; 1998–2018).

Status of Greater White-fronted Geese

Pacific Population White-fronted Geese

Pacific Population white-fronted geese (*Anser albifrons*) primarily nest on the YKD in Alaska and winter in the Central Valley of California (Figure 9). This population is monitored using a predicted fall population index, which is based on the number of indicated total birds from the YKD Coastal Zone Survey and the WBPHS in the Bristol Bay area (stratum 8) and interior portions of the YKD (stratum 9) and expanded by a factor derived from the correlation of these indices with past fall counts in Oregon and California (Pacific Flyway Council 2003). The 2018 predicted fall population index was 590,000, 20% less than the 2017 estimate of 735,600 (Figure 12). The prior 10-year trend was not significant ($P = 0.550$). Early spring phenology and good habitat conditions were observed on the YKD and in southwestern Alaska in 2018.

Mid-continent Population White-fronted Geese

Mid-continent Population white-fronted geese nest from central and northwestern Alaska to the west coast of Hudson Bay and the Melville Peninsula. This population concentrates in southern Saskatchewan and Alberta during the fall and in southern Central and Mississippi Flyway states and Mexico during the winter (Figure 9). This population is monitored via a fall staging survey in Saskatchewan and Alberta and the Midwinter Survey in Central and Mississippi Flyway states (Central, Mississippi, and Pacific Flyway Councils 2015). Indirect estimates of population size for Mid-continent Population white-fronted geese are also reported in the "Population Status of Migratory Game Birds in Canada" annual report (Canadian Wildlife Service Waterfowl Committee 2017). In 2017, 771,600 geese were counted during the fall survey, 23% less than the 2016 count of 1,000,100 (Figure 12). During 2008–2017, fall survey counts increased 4% per year ($P = 0.036$). The 2018 Midwinter Survey index in Central and Mississippi Flyway states was 806,900, which was 48% greater than the 2017 count of 546,000. These indices increased 8% per year during the

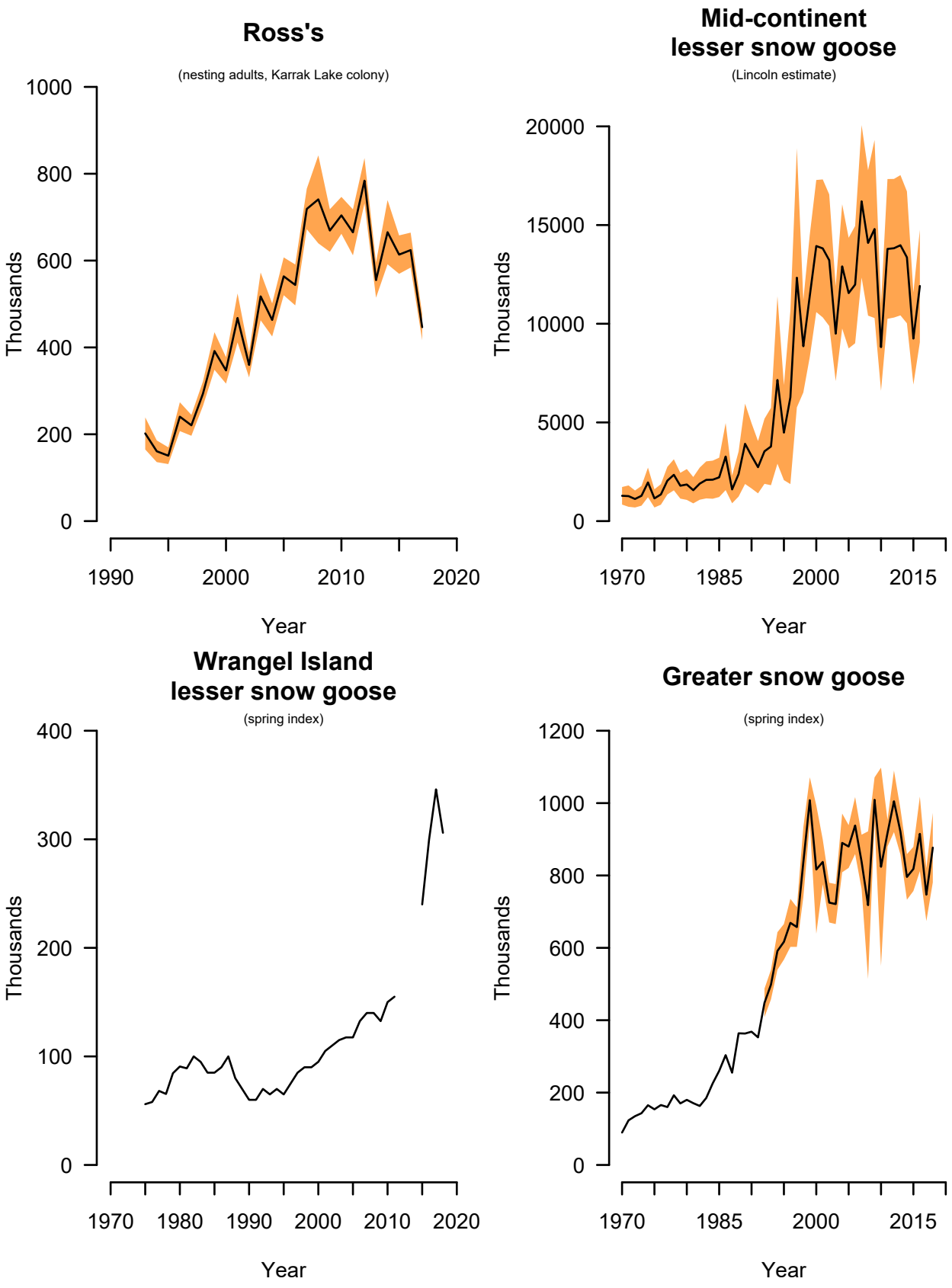

Figure 10. Estimated numbers (and 95% confidence intervals, where applicable) of Ross's and snow goose populations based on primary management surveys.

Table 16. White-fronted goose, emperor goose, brant, and tundra swan indices (in thousands) from primary monitoring surveys.

	Estimate/Count		Change from 2017		10-year Trend	
Population	2018	2017	%	*P*	%/yr	*P*
Pacific Population white-fronted geese	590	736	−20	–	+1	0.550
Mid-continent Population white-fronted geese[a]	772	1,000	−23	–	+4	0.036
Atlantic brant	170	162	+5	–	+1	0.558
Pacific brant	124	156	−21	–	−3	0.029
Emperor geese	30	30	0	0.993	+6	0.004
Western swans	152	132	+16	0.587	+2	0.124
Eastern swans	112	119	−6	–	+2	0.004

[a] Years presented refer to year–1.

past 10 years ($P = 0.029$). In 2018, breeding conditions were below average or average across most of the breeding range of Mid-continent Population white-fronted geese.

Status of Brant

Atlantic Brant (ATLB)

Atlantic brant (*Branta bernicla bernicla*) primarily nest on islands in the eastern Canadian Arctic and winter along the Atlantic Coast from Massachusetts to North Carolina (Figure 9). The Midwinter Survey provides an index of this population within its winter range in the Atlantic Flyway (Atlantic Flyway Council 2002). The 2018 Midwinter Survey index was 169,700, which was 5% greater than the 2017 count of 161,700 (Figure 12). These indices did not show a significant trend during the past 10 years ($P = 0.558$). Productivity from the previous year is estimated by the proportion of juveniles in the population during November and December. Juveniles comprised 18% of the population in 2017, which was equal to the long-term average. In 2018, breeding conditions were below average across most of the eastern Arctic.

Pacific Brant (PACB)

PACB include black brant (BLBR; *B. b. nigricans*) and western high arctic brant (WHAB; *B. b. bernicla*). BLBR nest across the YKD and North Slope in Alaska, Banks Island, other islands of the western and central Arctic, the Queen Maud Gulf, and Russia. They stage during fall at Izembek Lagoon, Alaska, and winter as far south as Mexico. WHAB nest on the Parry Islands of the Northwest Territories and Nunavut. They stage during fall at Izembek Lagoon, Alaska, and predominantly winter in the Padilla, Samish, and Fidalgo Bays of Washington and near Boundary Bay, British Columbia, although some individuals have been observed as far south as Mexico (Figure 9). Fall and winter counts in the U.S., Canada, and Mexico are the primary management indices for PACB (Pacific Flyway Council 2018). In 2018, 123,600 brant were counted, which was 21% less than the 2017 index of 155,700 (Figure 12). These indices decreased 3% per year since 2009 ($P = 0.029$). PACB are also monitored by various breeding ground surveys. An aerial photography survey of the 5 primary breeding colonies on the YKD recorded 9,200 brant in 2017, which was 21% less than the 2016 estimate of 11,700. The total indicated brant index from the 2018 YKD Coastal Zone Survey was 26,400 (20,500–32,300), similar to the 2017 index of 21,600 (16,100–27,100; $P = 0.235$). The total indicated brant index from the 2017 Arctic Coastal Plain Survey was 18,200 (10,600–25,800), similar to the 2016 index of 18,100 (9,300–26,900; $P = 0.069$). These three indices have not shown a significant trend

during the past ten years (P = 0.419, 0.315, and 0.066, respectively). Breeding conditions were variable throughout Alaska and the western Arctic in 2018, with early spring phenology on the YKD but late spring phenology in most other areas.

Status of Emperor Geese

Emperor geese (*C. canagica*) breed along coastal areas of the Bering Sea, with the largest concentration on the YKD in Alaska. Emperor geese stage along the Alaska Peninsula during the fall and spring and winter along the Aleutian Islands (Figure 11). This population is monitored during spring by the YKD Coastal Zone Survey (Pacific Flyway Council 2016*b*). In 2018, the total indicated bird index was 30,100 (26,600–33,600), similar to the 2017 index of 30,100 (26,100–34,100; $P = 0.993$). During the past ten years, these indices increased 6% per year ($P = 0.004$; Figure 12). In 2018, spring phenology was earlier than average on the YKD, similar to recent years.

Status of Swans

Western Population Tundra Swans

Western Population tundra swans (*Cygnus columbianus*) nest along the coastal lowlands of western Alaska, and the YKD is a primary breeding area. Western Population tundra swans primarily winter in California, Utah, and the Pacific Northwest (Figure 11). The management plan for Western Population tundra swans was updated in 2017, and the primary management indices are derived from the YKD Coastal Zone Survey and the WBPHS (stratum 8 [Bristol Bay], stratum 9 [inland portions of the YKD], stratum 10 [Seward Peninsula], and stratum 11 [Kotzebue Sound]; Pacific Flyway Council 2017). In 2018, the total swan index was 152,100 (100,600–203,600), similar to the 2017 index of 131,600 (78,300–184,800; $P = 0.587$). During the past 10 years, these indices did not show a significant trend ($P = 0.124$; Figure 12). Habitat conditions were generally good across western and southwestern Alaska.

Figure 11. Approximate ranges of emperor geese and Eastern and Western Populations of tundra swans in North America.

Eastern Population Tundra Swans

Eastern Population tundra swans nest from the Seward Peninsula of Alaska to the northeast shore of Hudson Bay and Baffin Island. The Mackenzie River Delta and adjacent areas in the Northwest Territories are of particular importance. This population predominantly winters in coastal areas from Maryland to North Carolina (Figure 11). The Midwinter Survey provides an index of this population within its winter range of the Atlantic and Mississippi Flyways (Atlantic, Mississippi, Central, and Pacific Flyway Councils 2007). During the 2018 Midwinter Survey, 111,600 swans were observed, 6% less than the 119,300 counted in 2017 (Figure 12). These indices increased 2% per year since 2009 ($P = 0.004$). Productivity from the previous year is estimated by the proportion of juveniles in the population during November and December. Juveniles comprised 12% of the population in 2017, which was slightly below the long-term average of 13%. In 2018, breeding conditions were generally below average in northern Alaska and across much of the western, central, and eastern Arctic, although excellent or good habitat conditions were observed along the Mackenzie River and in western Alaska.

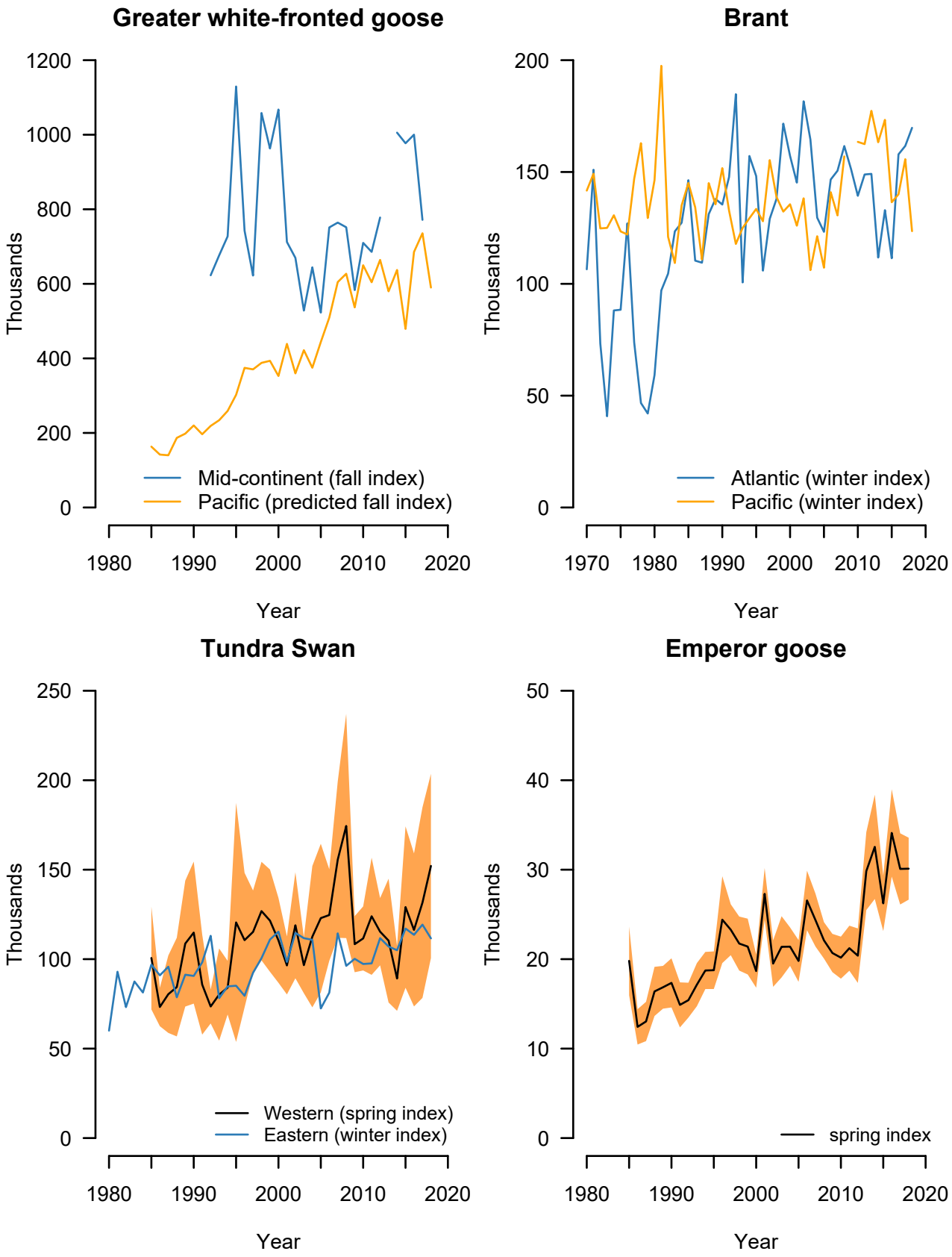

Figure 12. Estimated numbers (and 95% confidence intervals, where applicable) of greater white-fronted goose, brant, tundra swan, and emperor goose populations based on primary management surveys.

Trumpeter Swans

Trumpeter swans (*C. buccinator*) nest south of the Brooks Range and east of the YKD in Alaska and within localized areas of Yukon Territory, western Northwest Territories, southern Canadian provinces from British Columbia to Quebec, and some northern U.S. states from Washington to New York. There are three recognized North American populations: the Pacific Coast, Rocky Mountain, and Interior Populations. Trumpeter swan abundance and productivity is comprehensively monitored through the North American Trumpeter Swan Survey. This range-wide survey was first conducted in 1968, repeated in 1975, and has continued at 5-year intervals thereafter. The first survey in 1968 recorded 2,600 adult and subadult trumpeter swans. The most recent survey was completed in 2015, and 63,000 adult and subadult trumpeter swans were observed. Information from this, and other, trumpeter swan surveys can be found at: https://www.fws.gov/birds/surveys-and-data/reports-and-publications.php.

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Flyway and Regional Survey Reports

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Information from the Waterfowl Breeding Population and Habitat Survey

See Appendix A.1

Atlantic Population Canada Geese

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Southern Hudson Bay Population Canada Geese

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Mississippi Flyway Population Giant Canada Geese

O. Jones[b]

Central Flyway Arctic Nesting Canada Geese

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Ross's Geese and Mid-continent Lesser Snow Geese

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Wrangel Island Population Lesser Snow Geese

V. Baranyuk[d]

Greater Snow Geese

G. Gauthier[d] and J. Lefebvre[a]

Mid-continent Population White-fronted Geese

B. Bartzen[a], J. Jackson[b], T. Liddick, R. Spangler, K. Warner[a], and J. Whitaker[b]

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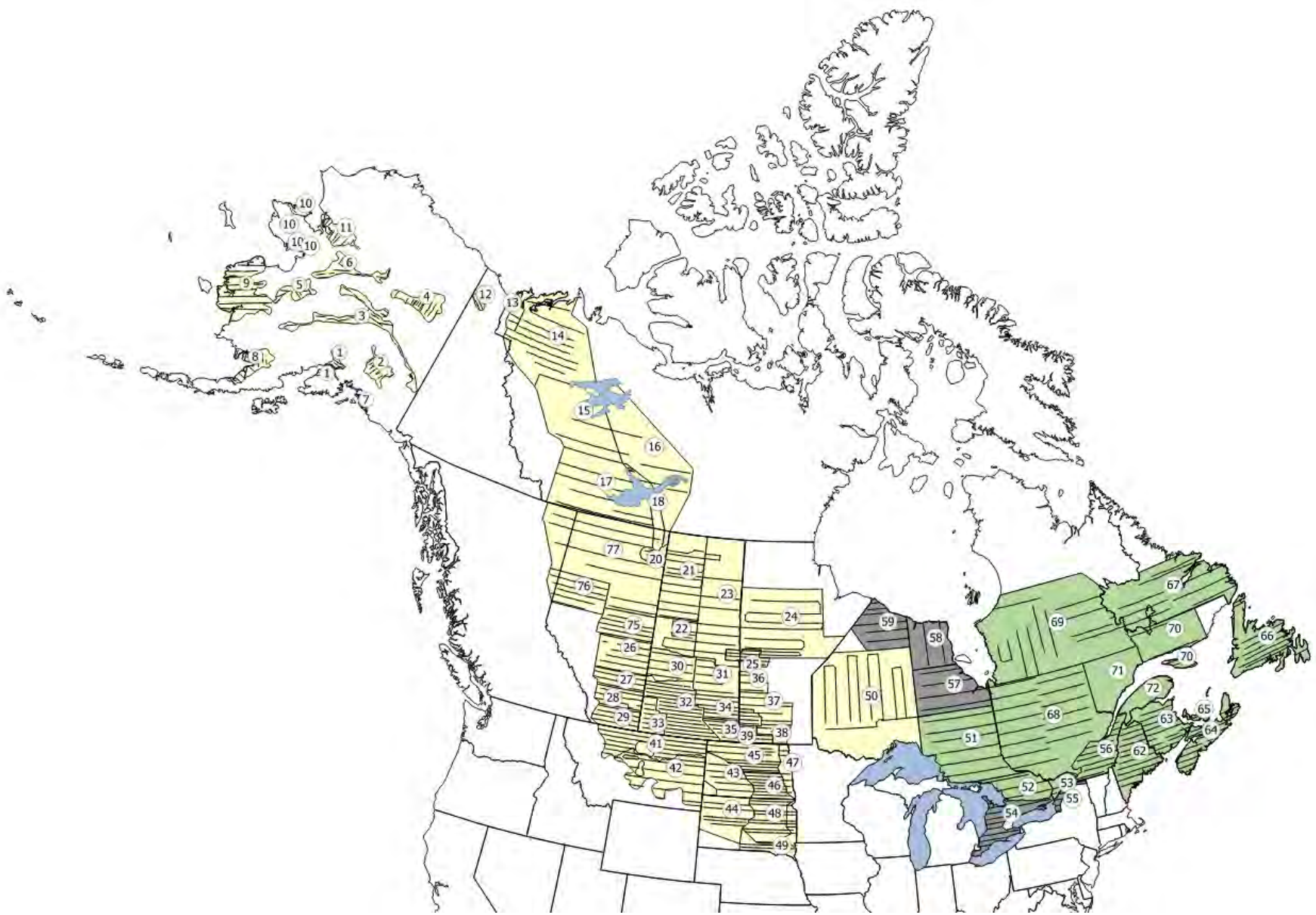
[a]Canadian Wildlife Service
[b]State, Provincial or Tribal Conservation Agency
[c]Ducks Unlimited Canada
[d]Other Organization
[e]U.S. Fish and Wildlife Service Retired
All others–U.S. Fish and Wildlife Service

B. Waterfowl Breeding Population and Habitat Survey map



Strata and transects of the Waterfowl Breeding Population and Habitat Survey (yellow = traditional survey area, green = eastern survey area, grey = discontinued strata).

C. Historical estimates of May ponds and regional waterfowl populations

Table C.1. Estimated number of May ponds and standard errors (in thousands) in portions of Prairie Canada and the northcentral U.S.

	Prairie Canada		Northcentral U.S.[a]		Total	
Year	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$
1961	1,977.20	165.40				
1962	2,369.10	184.60				
1963	2,482.00	129.30				
1964	3,370.70	173.00				
1965	4,378.80	212.20				
1966	4,554.50	229.30				
1967	4,691.20	272.10				
1968	1,985.70	120.20				
1969	3,547.60	221.90				
1970	4,875.00	251.20				
1971	4,053.40	200.40				
1972	4,009.20	250.90				
1973	2,949.50	197.60				
1974	6,390.10	308.30	1,840.80	197.20	8,230.90	366.00
1975	5,320.10	271.30	1,910.80	116.10	7,230.90	295.10
1976	4,598.80	197.10	1,391.50	99.20	5,990.30	220.70
1977	2,277.90	120.70	771.10	51.10	3,049.10	131.10
1978	3,622.10	158.00	1,590.40	81.70	5,212.40	177.90
1979	4,858.90	252.00	1,522.20	70.90	6,381.10	261.80
1980	2,140.90	107.70	761.40	35.80	2,902.30	113.50
1981	1,443.00	75.30	682.80	34.00	2,125.80	82.60
1982	3,184.90	178.60	1,458.00	86.40	4,642.80	198.40
1983	3,905.70	208.20	1,259.20	68.70	5,164.90	219.20
1984	2,473.10	196.60	1,766.20	90.80	4,239.30	216.50
1985	4,283.10	244.10	1,326.90	74.00	5,610.00	255.10
1986	4,024.70	174.40	1,734.80	74.40	5,759.50	189.60
1987	2,523.70	131.00	1,347.80	46.80	3,871.50	139.10
1988	2,110.10	132.40	790.70	39.40	2,900.80	138.10
1989	1,692.70	89.10	1,289.90	61.70	2,982.70	108.40
1990	2,817.30	138.30	691.20	45.90	3,508.50	145.70
1991	2,493.90	110.20	706.10	33.60	3,200.00	115.20
1992	2,783.90	141.60	825.00	30.80	3,608.90	144.90
1993	2,261.10	94.00	1,350.60	57.10	3,611.70	110.00
1994	3,769.10	173.90	2,215.60	88.80	5,984.80	195.30
1995	3,892.50	223.80	2,442.90	106.80	6,335.40	248.00
1996	5,002.60	184.90	2,479.70	135.30	7,482.20	229.10

Table C.1. Continued.

	Prairie Canada		Northcentral U.S.[a]		Total	
Year	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$
1997	5,061.00	180.30	2,397.20	94.40	7,458.20	203.50
1998	2,521.70	133.80	2,065.30	89.20	4,586.90	160.80
1999	3,862.00	157.20	2,842.20	256.80	6,704.30	301.20
2000	2,422.50	96.10	1,524.50	99.90	3,946.90	138.60
2001	2,747.20	115.60	1,893.20	91.50	4,640.40	147.40
2002	1,439.00	105.00	1,281.00	63.40	2,720.00	122.70
2003	3,522.30	151.80	1,667.80	67.40	5,190.10	166.10
2004	2,512.60	131.00	1,407.00	101.70	3,919.60	165.80
2005	3,920.50	196.70	1,460.70	79.70	5,381.20	212.20
2006	4,449.50	221.50	1,644.40	85.40	6,093.90	237.40
2007	5,040.20	261.80	1,962.50	102.50	7,002.70	281.20
2008	3,054.80	147.60	1,376.60	71.90	4,431.40	164.20
2009	3,568.10	148.00	2,866.00	123.10	6,434.00	192.50
2010	3,728.70	203.40	2,936.30	142.30	6,665.00	248.20
2011	4,892.70	197.50	3,239.50	127.40	8,132.20	235.00
2012	3,885.10	146.50	1,658.90	52.70	5,544.00	155.60
2013	4,550.50	185.50	2,341.20	99.00	6,891.70	210.20
2014	4,629.90	168.30	2,551.30	106.50	7,181.20	199.20
2015	4,151.00	146.30	2,156.80	86.00	6,307.70	169.70
2016	3,494.50	147.20	1,518.00	52.70	5,012.50	156.40
2017	4,330.30	157.70	1,765.70	92.20	6,096.00	182.70
2018	3,660.20	147.60	1,567.20	90.20	5,227.40	173.00

[a] No comparable survey data available for the northcentral U.S. during 1961–1973.

Table C.2. Breeding population estimates (in thousands) for total ducks[a] and mallards for states, provinces, or regions that conduct spring surveys.

	British Columbia		California		Michigan		Minnesota	
Year	Total ducks	Mallards	Total ducks	Mallards	Total ducks	Mallards	Total ducks	Mallards
1955								
1956								
1957								
1958								
1959								
1960								
1961								
1962								
1963								
1964								
1965								
1966								
1967								
1968							321.0	83.7
1969							323.2	88.8
1970							324.2	113.9
1971							277.1	78.5
1972							217.2	62.2
1973							389.5	99.8
1974							281.6	72.8
1975							471.6	175.8
1976							684.1	117.8
1977							501.1	134.2
1978							462.5	146.8
1979							552.4	158.7
1980							690.6	172.0
1981							439.8	154.8
1982							465.2	120.5
1983							367.1	155.8
1984							529.7	188.1
1985							562.9	216.9
1986							520.8	233.6
1987							589.0	192.3
1988							725.2	271.7
1989							813.6	273.0
1990							807.9	232.1
1991					408.4	289.3	753.7	225.0
1992			497.4	375.8	867.5	385.8	973.3	360.9
1993			666.7	359.0	742.8	437.2	837.2	305.8
1994			483.2	311.7	683.1	420.5	1,115.6	426.5
1995			589.7	368.5	791.9	524.1	797.1	319.4
1996			843.7	536.7	680.5	378.2	889.1	314.8
1997			824.3	511.3	784.0	489.3	868.1	407.4
1998			706.8	353.9	1,068.5	523.0	693.1	368.5
1999			851.0	560.1	744.6	466.1	680.5	316.4

Table C.2. Continued.

	British Columbia		California		Michigan		Minnesota	
Year	Total ducks	Mallards	Total ducks	Mallards	Total ducks	Mallards	Total ducks	Mallards
2000			562.4	347.6	793.9	427.2	747.8	318.1
2001			413.5	302.2	497.8	324.2	716.4	320.6
2002			392.0	265.3	742.5	323.2	1,171.5	366.6
2003			533.7	337.1	535.4	298.9	721.8	280.5
2004			412.8	262.4	624.5	342.0	1,008.3	375.3
2005			615.2	317.9	468.3	258.1	632.0	238.5
2006	407.8	101.1	649.4	399.4	412.2	244.6	521.1	160.7
2007	384.1	101.5	627.6	388.3	641.9	337.7	488.5	242.5
2008	375.1	80.6	554.3	297.1	437.5	200.5	739.6	297.6
2009	350.1	73.1	510.8	302.0	493.6	258.9	541.3	236.4
2010	339.6	81.2	541.3	367.9	595.3	338.3	530.7	241.9
2011	278.1	70.1	558.6	314.7	471.4	258.6	687.5	283.3
2012	322.0	83.3	529.7	387.1	860.1	439.3	468.6	225.0
2013	330.6	82.7	451.3	298.6	678.6	288.4	682.9	293.2
2014	352.7	82.6	448.7	238.7	395.3	230.1	474.4	257.0
2015	363.3	81.3	315.6	173.9	431.1	237.8	524.2	206.2
2016	318.7	73.9	417.8	263.8	502.6	278.1	787.1	250.2
2017	350.5	70.9	393.7	198.4	684.5	298.1	636.0	213.6
2018	346.3	79.3	549.2	272.9	452.4	251.4	692.6	295.4

[a] Species composition for the total duck estimate varies by region.

Table C.2. Continued.

	Nevada[b]	Northeast U.S.[c]		Oregon		Washington		Wisconsin	
Year	Mallards	Total ducks	Mallards	Total ducks	Mallards	Total ducks	Mallards	Total ducks	Mallards
1955									
1956									
1957									
1958									
1959	2.1								
1960	2.1								
1961	2.0								
1962	1.7								
1963	2.2								
1964	3.0								
1965	3.5								
1966	3.4								
1967	1.5								
1968	1.2								
1969	1.4								
1970	1.5								
1971	1.1								
1972	0.9								
1973	0.7							412.7	107.0
1974	0.7							435.2	94.3
1975	0.6							426.9	120.5
1976	0.6							379.5	109.9
1977	1.0							323.3	91.7
1978	0.6							271.3	61.6
1979	0.6					98.6	32.1	265.7	78.6
1980	0.9					113.7	34.1	248.1	116.5
1981	1.6					148.3	41.8	505.0	142.8
1982	1.1					146.4	49.8	218.7	89.5
1983	1.5					149.5	47.6	202.3	119.5
1984	1.4					196.3	59.3	210.0	104.8
1985	1.5					216.2	63.1	192.8	73.9
1986	1.3					203.8	60.8	262.0	110.8
1987	1.5					183.6	58.3	389.8	136.9
1988	1.3					241.8	67.2	287.1	148.9
1989	1.3					162.3	49.8	462.5	180.7
1990	1.3					168.9	56.9	328.6	151.4
1991	1.4					140.8	43.7	435.8	172.4
1992	0.9					116.3	41.0	683.8	249.7
1993	1.2	1,158.1	686.6			149.8	55.0	379.4	174.5
1994	1.4	1,297.3	856.3	323.6	116.4	123.9	52.7	571.2	283.4
1995	1.0	1,408.5	864.1	215.9	77.5	147.3	58.9	592.4	242.2
1996	1.7	1,430.9	848.6	288.4	102.2	163.3	61.6	536.3	314.4

Table C.2. Continued.

	Nevada[b]	Northeast U.S.[c]		Oregon		Washington		Wisconsin	
Year	Mallards	Total ducks	Mallards	Total ducks	Mallards	Total ducks	Mallards	Total ducks	Mallards
1997	2.5	1,423.5	795.2	359.5	121.2	172.8	67.0	409.3	181.0
1998	2.1	1,444.0	775.2	345.1	124.9	185.3	79.0	412.8	186.9
1999	2.3	1,522.7	880.0	320.0	125.6	200.2	86.2	476.6	248.4
2000	2.1	1,933.5	762.6	314.9	110.9	143.6	47.7	744.4	454.0
2001	2.0	1,397.4	809.4			146.4	50.5	440.1	183.5
2002	0.7	1,466.2	833.7	364.6	104.5	133.3	44.7	740.8	378.5
2003	1.7	1,266.2	731.9	246.1	89.0	127.8	39.8	533.5	261.3
2004	1.7	1,416.9	805.9	229.8	82.5	114.9	40.0	651.5	229.2
2005	0.7	1,416.2	753.6	210.4	74.1	111.5	40.8	724.3	317.2
2006	1.8	1,384.2	725.2	251.2	81.1	135.4	45.5	522.6	219.5
2007	2.1	1,500.1	687.6	319.1	92.5	128.3	46.1	470.6	210.0
2008	1.9	1,197.1	619.1	224.3	75.4	120.9	50.6	626.9	188.4
2009	12.7	1,271.1	666.8	186.0	72.6	116.5	47.5	502.4	200.5
2010	8.9	1,302.0	651.7	205.1	66.8	197.8	91.8	386.5	199.1
2011	2.3	1,265.0	586.1	158.4	61.6	157.1	71.3	513.7	187.9
2012	4.1	1,309.9	612.6	263.5	88.8	168.9	89.4	521.1	197.0
2013	8.8	1,281.8	604.2	251.7	84.3	156.5	74.1	527.3	181.2
2014	4.2	1,343.8	634.6	315.2	85.3	117.2	86.5	395.1	158.7
2015	5.5	1,197.2	540.1	279.7	87.4	193.1	86.4	372.8	176.2
2016	14.4	1,240.8	551.3	213.6	87.3	121.5	59.9	390.5	164.1
2017	6.4	1,330.8	448.5	239.9	71.7	242.2	103.4	479.1	180.9
2018	13.9	1,448.1	482.1	293.9	97.1	281.1	124.9	439.4	216.7

[b] Survey redesigned in 2009, and not comparable with previous years.

[c] Includes all or portions of Connecticut, Delaware, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia.

Table C.3. Breeding population estimates and standard errors (in thousands) for 10 species of ducks from the traditional survey area (strata 1–18, 20–50, 75–77), 1955–2018.

	Mallard		Gadwall		American wigeon		Green-winged teal		Blue-winged teal	
Year	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$
1955	8,777.3	457.1	651.5	149.5	3,216.8	297.8	1,807.2	291.5	5,305.2	567.6
1956	10,452.7	461.8	772.6	142.4	3,145.0	227.8	1,525.3	236.2	4,997.6	527.6
1957	9,296.9	443.5	666.8	148.2	2,919.8	291.5	1,102.9	161.2	4,299.5	467.3
1958	11,234.2	555.6	502.0	89.6	2,551.7	177.9	1,347.4	212.2	5,456.6	483.7
1959	9,024.3	466.6	590.0	72.7	3,787.7	339.2	2,653.4	459.3	5,099.3	332.7
1960	7,371.7	354.1	784.1	68.4	2,987.6	407.0	1,426.9	311.0	4,293.0	294.3
1961	7,330.0	510.5	654.8	77.5	3,048.3	319.9	1,729.3	251.5	3,655.3	298.7
1962	5,535.9	426.9	905.1	87.0	1,958.7	145.4	722.9	117.6	3,011.1	209.8
1963	6,748.8	326.8	1,055.3	89.5	1,830.8	169.9	1,242.3	226.9	3,723.6	323.0
1964	6,063.9	385.3	873.4	73.7	2,589.6	259.7	1,561.3	244.7	4,020.6	320.4
1965	5,131.7	274.8	1,260.3	114.8	2,301.1	189.4	1,282.0	151.0	3,594.5	270.4
1966	6,731.9	311.4	1,680.4	132.4	2,318.4	139.2	1,617.3	173.6	3,733.2	233.6
1967	7,509.5	338.2	1,384.6	97.8	2,325.5	136.2	1,593.7	165.7	4,491.5	305.7
1968	7,089.2	340.8	1,949.0	213.9	2,298.6	156.1	1,430.9	146.6	3,462.5	389.1
1969	7,531.6	280.2	1,573.4	100.2	2,941.4	168.6	1,491.0	103.5	4,138.6	239.5
1970	9,985.9	617.2	1,608.1	123.5	3,469.9	318.5	2,182.5	137.7	4,861.8	372.3
1971	9,416.4	459.5	1,605.6	123.0	3,272.9	186.2	1,889.3	132.9	4,610.2	322.8
1972	9,265.5	363.9	1,622.9	120.1	3,200.1	194.1	1,948.2	185.8	4,278.5	230.5
1973	8,079.2	377.5	1,245.6	90.3	2,877.9	197.4	1,949.2	131.9	3,332.5	220.3
1974	6,880.2	351.8	1,592.4	128.2	2,672.0	159.3	1,864.5	131.2	4,976.2	394.6
1975	7,726.9	344.1	1,643.9	109.0	2,778.3	192.0	1,664.8	148.1	5,885.4	337.4
1976	7,933.6	337.4	1,244.8	85.7	2,505.2	152.7	1,547.5	134.0	4,744.7	294.5
1977	7,397.1	381.8	1,299.0	126.4	2,575.1	185.9	1,285.8	87.9	4,462.8	328.4
1978	7,425.0	307.0	1,558.0	92.2	3,282.4	208.0	2,174.2	219.1	4,498.6	293.3
1979	7,883.4	327.0	1,757.9	121.0	3,106.5	198.2	2,071.7	198.5	4,875.9	297.6
1980	7,706.5	307.2	1,392.9	98.8	3,595.5	213.2	2,049.9	140.7	4,895.1	295.6
1981	6,409.7	308.4	1,395.4	120.0	2,946.0	173.0	1,910.5	141.7	3,720.6	242.1
1982	6,408.5	302.2	1,633.8	126.2	2,458.7	167.3	1,535.7	140.2	3,657.6	203.7
1983	6,456.0	286.9	1,519.2	144.3	2,636.2	181.4	1,875.0	148.0	3,366.5	197.2
1984	5,415.3	258.4	1,515.0	125.0	3,002.2	174.2	1,408.2	91.5	3,979.3	267.6
1985	4,960.9	234.7	1,303.0	98.2	2,050.7	143.7	1,475.4	100.3	3,502.4	246.3
1986	6,124.2	241.6	1,547.1	107.5	1,736.5	109.9	1,674.9	136.1	4,478.8	237.1
1987	5,789.8	217.9	1,305.6	97.1	2,012.5	134.3	2,006.2	180.4	3,528.7	220.2
1988	6,369.3	310.3	1,349.9	121.1	2,211.1	139.1	2,060.8	188.3	4,011.1	290.4
1989	5,645.4	244.1	1,414.6	106.6	1,972.9	106.0	1,841.7	166.4	3,125.3	229.8
1990	5,452.4	238.6	1,672.1	135.8	1,860.1	108.3	1,789.5	172.7	2,776.4	178.7
1991	5,444.6	205.6	1,583.7	111.8	2,254.0	139.5	1,557.8	111.3	3,763.7	270.8
1992	5,976.1	241.0	2,032.8	143.4	2,208.4	131.9	1,773.1	123.7	4,333.1	263.2
1993	5,708.3	208.9	1,755.2	107.9	2,053.0	109.3	1,694.5	112.7	3,192.9	205.6
1994	6,980.1	282.8	2,318.3	145.2	2,382.2	130.3	2,108.4	152.2	4,616.2	259.2
1995	8,269.4	287.5	2,835.7	187.5	2,614.5	136.3	2,300.6	140.3	5,140.0	253.3
1996	7,941.3	262.9	2,984.0	152.5	2,271.7	125.4	2,499.5	153.4	6,407.4	353.9

Continued.

	Mallard		Gadwall		American wigeon		Green-winged teal		Blue-winged teal	
Year	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$
1997	9,939.7	308.5	3,897.2	264.9	3,117.6	161.6	2,506.6	142.5	6,124.3	330.7
1998	9,640.4	301.6	3,742.2	205.6	2,857.7	145.3	2,087.3	138.9	6,398.8	332.3
1999	10,805.7	344.5	3,235.5	163.8	2,920.1	185.5	2,631.0	174.6	7,149.5	364.5
2000	9,470.2	290.2	3,158.4	200.7	2,733.1	138.8	3,193.5	200.1	7,431.4	425.0
2001	7,904.0	226.9	2,679.2	136.1	2,493.5	149.6	2,508.7	156.4	5,757.0	288.8
2002	7,503.7	246.5	2,235.4	135.4	2,334.4	137.9	2,333.5	143.8	4,206.5	227.9
2003	7,949.7	267.3	2,549.0	169.9	2,551.4	156.9	2,678.5	199.7	5,518.2	312.7
2004	7,425.3	282.0	2,589.6	165.6	1,981.3	114.9	2,460.8	145.2	4,073.0	238.0
2005	6,755.3	280.8	2,179.1	131.0	2,225.1	139.2	2,156.9	125.8	4,585.5	236.3
2006	7,276.5	223.7	2,824.7	174.2	2,171.2	115.7	2,587.2	155.3	5,859.6	303.5
2007	8,307.3	285.8	3,355.9	206.2	2,806.8	152.0	2,890.3	196.1	6,707.6	362.2
2008	7,723.8	256.8	2,727.7	158.9	2,486.6	151.3	2,979.7	194.4	6,640.1	337.3
2009	8,512.4	248.3	3,053.5	166.3	2,468.6	135.4	3,443.6	219.9	7,383.8	396.8
2010	8,430.1	284.9	2,976.7	161.6	2,424.6	131.5	3,475.9	207.2	6,328.5	382.6
2011	9,182.6	267.8	3,256.9	196.9	2,084.0	110.1	2,900.1	170.7	8,948.5	418.2
2012	10,601.5	324.0	3,585.6	208.7	2,145.0	145.6	3,471.2	207.9	9,242.3	425.1
2013	10,371.9	360.6	3,351.4	204.5	2,644.3	169.2	3,053.4	173.7	7,731.7	363.2
2014	10,899.8	347.6	3,811.0	206.0	3,116.7	190.4	3,439.9	247.4	8,541.5	461.9
2015	11,643.3	361.8	3,834.1	219.4	3,037.0	199.2	4,080.9	269.8	8,547.3	401.1
2016	11,792.5	367.4	3,712.0	197.3	3,411.3	196.4	4,275.4	329.8	6,689.4	340.1
2017	10,488.5	333.9	4,180.0	209.0	2,777.1	156.0	3,605.3	233.3	7,888.9	395.8
2018	9,255.2	298.9	2,885.9	161.7	2,820.4	166.5	3,042.7	213.9	6,450.5	307.7

Continued.

	Northern shoveler		Northern pintail		Redhead		Canvasback		Scaup	
Year	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$
1955	1,642.8	218.7	9,775.1	656.1	539.9	98.9	589.3	87.8	5,620.1	582.1
1956	1,781.4	196.4	10,372.8	694.4	757.3	119.3	698.5	93.3	5,994.1	434.0
1957	1,476.1	181.8	6,606.9	493.4	509.1	95.7	626.1	94.7	5,766.9	411.7
1958	1,383.8	185.1	6,037.9	447.9	457.1	66.2	746.8	96.1	5,350.4	355.1
1959	1,577.6	301.1	5,872.7	371.6	498.8	55.5	488.7	50.6	7,037.6	492.3
1960	1,824.5	130.1	5,722.2	323.2	497.8	67.0	605.7	82.4	4,868.6	362.5
1961	1,383.0	166.5	4,218.2	496.2	323.3	38.8	435.3	65.7	5,380.0	442.2
1962	1,269.0	113.9	3,623.5	243.1	507.5	60.0	360.2	43.8	5,286.1	426.4
1963	1,398.4	143.8	3,846.0	255.6	413.4	61.9	506.2	74.9	5,438.4	357.9
1964	1,718.3	240.3	3,291.2	239.4	528.1	67.3	643.6	126.9	5,131.8	386.1
1965	1,423.7	114.1	3,591.9	221.9	599.3	77.7	522.1	52.8	4,640.0	411.2
1966	2,147.0	163.9	4,811.9	265.6	713.1	77.6	663.1	78.0	4,439.2	356.2
1967	2,314.7	154.6	5,277.7	341.9	735.7	79.0	502.6	45.4	4,927.7	456.1
1968	1,684.5	176.8	3,489.4	244.6	499.4	53.6	563.7	101.3	4,412.7	351.8
1969	2,156.8	117.2	5,903.9	296.2	633.2	53.6	503.5	53.7	5,139.8	378.5
1970	2,230.4	117.4	6,392.0	396.7	622.3	64.3	580.1	90.4	5,662.5	391.4
1971	2,011.4	122.7	5,847.2	368.1	534.4	57.0	450.7	55.2	5,143.3	333.8
1972	2,466.5	182.8	6,979.0	364.5	550.9	49.4	425.9	46.0	7,997.0	718.0
1973	1,619.0	112.2	4,356.2	267.0	500.8	57.7	620.5	89.1	6,257.4	523.1
1974	2,011.3	129.9	6,598.2	345.8	626.3	70.8	512.8	56.8	5,780.5	409.8
1975	1,980.8	106.7	5,900.4	267.3	831.9	93.5	595.1	56.1	6,460.0	486.0
1976	1,748.1	106.9	5,475.6	299.2	665.9	66.3	614.4	70.1	5,818.7	348.7
1977	1,451.8	82.1	3,926.1	246.8	634.0	79.9	664.0	74.9	6,260.2	362.8
1978	1,975.3	115.6	5,108.2	267.8	724.6	62.2	373.2	41.5	5,984.4	403.0
1979	2,406.5	135.6	5,376.1	274.4	697.5	63.8	582.0	59.8	7,657.9	548.6
1980	1,908.2	119.9	4,508.1	228.6	728.4	116.7	734.6	83.8	6,381.7	421.2
1981	2,333.6	177.4	3,479.5	260.5	594.9	62.0	620.8	59.1	5,990.9	414.2
1982	2,147.6	121.7	3,708.8	226.6	616.9	74.2	513.3	50.9	5,532.0	380.9
1983	1,875.7	105.3	3,510.6	178.1	711.9	83.3	526.6	58.9	7,173.8	494.9
1984	1,618.2	91.9	2,964.8	166.8	671.3	72.0	530.1	60.1	7,024.3	484.7
1985	1,702.1	125.7	2,515.5	143.0	578.2	67.1	375.9	42.9	5,098.0	333.1
1986	2,128.2	112.0	2,739.7	152.1	559.6	60.5	438.3	41.5	5,235.3	355.5
1987	1,950.2	118.4	2,628.3	159.4	502.4	54.9	450.1	77.9	4,862.7	303.8
1988	1,680.9	210.4	2,005.5	164.0	441.9	66.2	435.0	40.2	4,671.4	309.5
1989	1,538.3	95.9	2,111.9	181.3	510.7	58.5	477.4	48.4	4,342.1	291.3
1990	1,759.3	118.6	2,256.6	183.3	480.9	48.2	539.3	60.3	4,293.1	264.9
1991	1,716.2	104.6	1,803.4	131.3	445.6	42.1	491.2	66.4	5,254.9	364.9
1992	1,954.4	132.1	2,098.1	161.0	595.6	69.7	481.5	97.3	4,639.2	291.9
1993	2,046.5	114.3	2,053.4	124.2	485.4	53.1	472.1	67.6	4,080.1	249.4
1994	2,912.0	141.4	2,972.3	188.0	653.5	66.7	525.6	71.1	4,529.0	253.6
1995	2,854.9	150.3	2,757.9	177.6	888.5	90.6	770.6	92.2	4,446.4	277.6
1996	3,449.0	165.7	2,735.9	147.5	834.2	83.1	848.5	118.3	4,217.4	234.5
1997	4,120.4	194.0	3,558.0	194.2	918.3	77.2	688.8	57.2	4,112.3	224.2

Continued.

	Northern shoveler		Northern pintail		Redhead		Canvasback		Scaup	
Year	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$	$\widehat{N}$	$\widehat{SE}$
1998	3,183.2	156.5	2,520.6	136.8	1,005.1	122.9	685.9	63.8	3,471.9	191.2
1999	3,889.5	202.1	3,057.9	230.5	973.4	69.5	716.0	79.1	4,411.7	227.9
2000	3,520.7	197.9	2,907.6	170.5	926.3	78.1	706.8	81.0	4,026.3	205.3
2001	3,313.5	166.8	3,296.0	266.6	712.0	70.2	579.8	52.7	3,694.0	214.9
2002	2,318.2	125.6	1,789.7	125.2	564.8	69.0	486.6	43.8	3,524.1	210.3
2003	3,619.6	221.4	2,558.2	174.8	636.8	56.6	557.6	48.0	3,734.4	225.5
2004	2,810.4	163.9	2,184.6	155.2	605.3	51.5	617.2	64.6	3,807.2	202.3
2005	3,591.5	178.6	2,560.5	146.8	592.3	51.7	520.6	52.9	3,386.9	196.4
2006	3,680.2	236.5	3,386.4	198.7	916.3	86.1	691.0	69.6	3,246.7	166.9
2007	4,552.8	247.5	3,335.3	160.4	1,009.0	84.7	864.9	86.2	3,452.2	195.3
2008	3,507.8	168.4	2,612.8	143.0	1,056.0	120.4	488.7	45.4	3,738.3	220.1
2009	4,376.3	224.1	3,225.0	166.9	1,044.1	106.3	662.1	57.4	4,172.1	232.3
2010	4,057.4	198.4	3,508.6	216.4	1,064.2	99.5	585.2	50.8	4,244.4	247.9
2011	4,641.0	232.8	4,428.6	267.9	1,356.1	128.3	691.6	46.0	4,319.3	261.1
2012	5,017.6	254.2	3,473.1	192.4	1,269.9	99.2	759.9	68.5	5,238.6	296.8
2013	4,751.0	202.3	3,335.0	188.4	1,202.2	90.5	787.0	57.6	4,165.7	250.8
2014	5,278.9	265.3	3,220.3	179.7	1,278.7	102.5	685.3	50.7	4,611.1	253.3
2015	4,391.4	219.0	3,043.0	182.5	1,195.9	92.9	757.3	63.3	4,395.3	252.5
2016	3,966.9	189.0	2,618.5	204.2	1,288.8	115.4	736.5	68.8	4,991.7	297.6
2017	4,353.1	202.3	2,889.2	206.2	1,115.4	91.8	732.5	61.7	4,371.7	228.7
2018	4,207.9	196.5	2,365.3	150.2	999.0	85.3	686.1	59.1	3,989.3	212.5

Table C.3. Total breeding duck estimates for the traditional survey area, in thousands.

	Traditional Survey Area[a]	
Year	$\widehat{N}$	$\widehat{SE}$
1955	39,603.6	1,264.0
1956	42,035.2	1,177.3
1957	34,197.1	1,016.6
1958	36,528.1	1,013.6
1959	40,089.9	1,103.6
1960	32,080.5	876.8
1961	29,829.0	1,009.0
1962	25,038.9	740.6
1963	27,609.5	736.6
1964	27,768.8	827.5
1965	25,903.1	694.4
1966	30,574.2	689.5
1967	32,688.6	796.1
1968	28,971.2	789.4
1969	33,760.9	674.6
1970	39,676.3	1,008.1
1971	36,905.1	821.8
1972	40,748.0	987.1
1973	32,573.9	805.3
1974	35,422.5	819.5
1975	37,792.8	836.2
1976	34,342.3	707.8
1977	32,049.0	743.8
1978	35,505.6	745.4
1979	38,622.0	843.4
1980	36,224.4	737.9
1981	32,267.3	734.9
1982	30,784.0	678.8
1983	32,635.2	725.8
1984	31,004.9	716.5
1985	25,638.3	574.9
1986	29,092.8	609.3
1987	27,412.1	562.1
1988	27,361.7	660.8
1989	25,112.8	555.4
1990	25,079.2	539.9
1991	26,605.6	588.7
1992	29,417.9	605.6
1993	26,312.4	493.9
1994	32,523.5	598.2
1995	35,869.6	629.4
1996	37,753.0	779.6

Table C.3. Continued.

Year	Traditional Survey Area[a]	
	$\widehat{N}$	$\widehat{SE}$
1997	42,556.3	718.9
1998	39,081.9	652.0
1999	43,435.8	733.9
2000	41,838.3	740.2
2001	36,177.5	633.1
2002	31,181.1	547.8
2003	36,225.1	664.7
2004	32,164.0	579.8
2005	31,734.9	555.2
2006	36,160.3	614.4
2007	41,172.2	724.8
2008	37,276.5	638.3
2009	42,004.8	701.9
2010	40,893.8	718.4
2011	45,554.3	766.5
2012	48,575.3	796.8
2013	45,607.3	749.8
2014	49,152.2	831.1
2015	49,521.7	812.1
2016	48,362.8	827.6
2017	47,265.6	773.6
2018	41,193.2	662.1

[a] Total ducks in the traditional survey area include species in Appendix C.3 plus American black ducks, ring-necked duck, goldeneyes, bufflehead, and ruddy duck.

Table C.4. Breeding population estimates and 90% credibility intervals (in thousands) for the 6 most abundant species of ducks in the eastern survey area, 1998–2018[a].

	Mallard		American black duck		Green-winged teal		Ring-necked duck		Goldeneyes[b]		Mergansers[c]	
Year	$\widehat{N}$	90% CI	$\widehat{N}$	90% CI	$\widehat{N}$	90% CI	$\widehat{N}$	90% CI	$\widehat{N}$	90% CI	$\widehat{N}$	90% CI
1998	1,411.4	(1,209.2, 1,642.9)	958.6	(807.3, 1,116.8)	311.7	(222.2, 423.5)	589.8	(430.6, 770.9)	537.9	(370.3, 745.6)	553.8	(457.0, 657.7)
1999	1,407.4	(1,204.1, 1,639.8)	940.0	(813.7, 1,074.1)	394.4	(285.6, 518.9)	699.9	(507.8, 920.7)	648.8	(461.3, 857.5)	588.0	(495.7, 697.7)
2000	1,355.4	(1,158.0, 1,566.8)	818.9	(725.0, 920.5)	368.1	(273.7, 473.9)	941.6	(609.2, 1,482.4)	631.4	(429.6, 891.6)	569.6	(484.1, 667.8)
2001	1,369.9	(1,168.4, 1,590.5)	812.7	(705.7, 933.6)	309.1	(221.9, 404.4)	663.6	(500.0, 860.4)	734.3	(511.7, 1,007.7)	546.3	(459.7, 637.6)
2002	1,351.7	(1,154.9, 1,569.1)	991.3	(850.4, 1,143.6)	411.1	(297.2, 530.7)	673.7	(511.9, 861.1)	841.9	(568.2, 1,178.4)	759.6	(645.3, 881.7)
2003	1,322.5	(1,128.6, 1,548.0)	919.4	(775.9, 1,065.1)	397.5	(287.6, 530.8)	673.0	(527.9, 845.1)	637.8	(431.6, 918.7)	657.1	(556.0, 766.9)
2004	1,323.8	(1,125.8, 1,550.1)	949.1	(792.5, 1,120.5)	463.0	(334.9, 615.8)	746.2	(551.0, 975.2)	576.6	(414.1, 774.2)	671.1	(571.8, 782.7)
2005	1,285.1	(1,087.6, 1,508.7)	832.0	(716.7, 954.8)	347.1	(248.1, 467.2)	626.5	(487.4, 773.2)	509.0	(374.6, 669.2)	644.5	(547.3, 754.7)
2006	1,242.0	(1,056.7, 1,450.7)	890.7	(763.4, 1,026.9)	342.4	(250.2, 460.5)	657.8	(505.3, 827.7)	467.5	(343.5, 616.4)	577.7	(489.4, 675.5)
2007	1,263.8	(1,060.5, 1,489.0)	959.1	(833.4, 1,082.3)	438.8	(295.3, 623.2)	841.3	(657.6, 1,052.3)	654.5	(463.8, 886.7)	659.1	(558.0, 774.7)
2008	1,235.4	(1,039.5, 1,456.6)	863.0	(742.8, 1,009.5)	409.7	(287.4, 558.2)	675.5	(509.6, 874.7)	610.9	(422.5, 835.8)	592.9	(503.5, 692.1)
2009	1,228.3	(1,030.5, 1,457.2)	890.1	(738.1, 1,064.6)	429.7	(298.6, 585.7)	690.8	(507.8, 909.8)	539.0	(383.7, 733.9)	623.2	(526.3, 726.6)
2010	1,140.3	(963.9 , 1,340.8)	777.8	(654.5, 913.9)	417.3	(287.3, 572.9)	678.3	(520.1, 866.0)	531.5	(373.7, 729.4)	519.5	(436.0, 611.7)
2011	1,180.1	(985.2 , 1,397.6)	833.1	(679.3, 998.5)	404.0	(275.1, 560.2)	615.2	(476.8, 772.9)	535.1	(382.9, 717.7)	559.4	(468.2, 655.7)
2012	1,158.0	(979.6 , 1,373.1)	895.3	(752.0, 1,052.0)	372.5	(263.6, 506.8)	637.9	(479.6, 824.6)	569.9	(394.5, 825.5)	582.4	(490.6, 679.5)
2013	1,226.4	(1,007.6, 1,481.5)	895.6	(733.8, 1,090.1)	406.7	(284.9, 558.4)	795.3	(570.6, 1,080.5)	615.5	(425.0, 873.9)	629.1	(516.6, 756.2)
2014	1,157.9	(966.8 , 1,382.3)	885.4	(746.7, 1,050.5)	314.4	(220.5, 426.7)	598.7	(459.9, 767.3)	568.4	(360.9, 865.7)	553.8	(467.0, 649.5)
2015	1,110.4	(925.8 , 1,317.9)	878.7	(705.3, 1,087.0)	321.0	(226.0, 447.3)	719.9	(494.2, 1,006.5)	439.0	(315.2, 588.5)	549.0	(464.5, 643.7)
2016	1,095.7	(916.7 , 1,312.5)	954.4	(767.1, 1,158.4)	328.0	(227.5, 454.4)	740.8	(559.7, 972.9)	496.8	(349.1, 704.4)	588.9	(499.6, 688.6)
2017	1,107.2	(918.1 , 1,331.2)	782.2	(652.1, 921.8)	352.1	(252.1, 465.3)	617.3	(450.0, 819.2)	557.2	(390.0, 799.0)	687.0	(584.1, 801.0)
2018	1,056.2	(880.3 , 1,264.7)	712.3	(611.7, 819.1)	345.7	(249.0, 467.1)	629.4	(467.6, 837.7)	486.4	(334.3, 672.7)	656.0	(555.5, 764.3)

[a] Estimates for six most abundant species in the eastern survey area. Estimates for black ducks, green-winged teal, ring-necked ducks, goldeneye, and mergansers are at the eastern survey scale (strata 51–53, 56, 62–72) and mallards at the eastern North America scale (eastern survey area plus Virginia north to New Hampshire)

[b] Common and Barrow's.

[c] Common, red-breasted, and hooded.

D. Historical estimates of goose and swan populations

Table D.1. Abundance indices (in thousands) for North American Canada goose populations, 1969–2018.

Year	North Atlantic[a,b]	Atlantic[a,b]	Atlantic Flyway Resident[a]	Mississippi Flyway Giant[a]	W. Prairie & Great Plains[a]	Central Flyway Arctic Nesting[c]	Hi-line[a]
1969/70					80.4		58.3
1970/71					98.9		99.0
1971/72					83.0		52.4
1972/73					78.8		29.5
1973/74					66.8		32.9
1974/75					74.4		28.0
1975/76					99.9		39.3
1976/77					94.0		39.4
1977/78					227.9		38.1
1978/79					174.7		48.9
1979/80					152.1		49.3
1980/81					184.9		48.7
1981/82					162.1		52.4
1982/83					214.2		71.5
1983/84					182.4		103.1
1984/85					217.7		89.1
1985/86					232.1		98.2
1986/87					235.0	1,080.4	90.6
1987/88					338.9	1,114.2	126.0
1988/89					418.3	1,215.6	120.6
1989/90	44.8				366.3	1,157.8	180.9
1990/91	45.4				318.2	1,736.3	143.7
1991/92	42.3				328.1	1,980.5	163.8
1992/93	50.4	93.0		779.4	346.5	1,084.5	153.7
1993/94	47.6	43.2		909.4	371.0	3,515.2	156.2
1994/95	45.7	34.0		941.6	417.7	1,076.3	230.3
1995/96	59.0	51.5		1,037.3	451.4	904.6	196.2
1996/97	54.5	72.1		957.0	487.3	3,908.1	203.7
1997/98	50.5	48.6		1,140.5	587.1	5,523.8	252.0
1998/99	60.8	83.7		1,163.3	702.1	2,876.1	196.6
1999/00	50.9	95.8		1,436.7	717.7	5,095.5	279.3
2000/01	50.8	135.2		1,296.3	704.5	3,208.0	252.8
2001/02	50.7	182.4		1,415.2	670.9	4,162.4	231.0
2002/03	48.3	174.9	1,126.7	1,416.3	764.1	2,825.3	231.5
2003/04	53.3	191.8	1,073.1	1,430.4	797.7	3,043.0	200.5
2004/05	46.2	175.7	1,167.1	1,367.0	775.6	3,717.1	236.2
2005/06	47.6	186.1	1,144.0	1,575.2	816.1	3,242.4	208.0
2006/07	52.7	207.3	1,128.0	1,454.7	979.6	2,922.3	298.8
2007/08	48.2	174.0	1,024.9	1,461.7	957.1	2,693.2	337.3
2008/09	50.2	186.8	1,006.1	1,448.3	1,049.7	4,262.6	298.4

Table D.1. Continued.

Year	North Atlantic[a,b]	Atlantic[a,b]	Atlantic Flyway Resident[a]	Mississippi Flyway Giant[a]	W. Prairie & Great Plains[a]	Central Flyway Arctic Nesting[c]	Hi-line[a]
2009/10	48.7	165.1	977.1	1,638.0	1,111.1	4,749.6	269.5
2010/11	51.7	216.0	1,015.1	1,670.3	1,309.9	3,191.8	265.4
2011/12	51.6	190.3	879.8	1,766.2	1,369.6	3,360.3	483.6
2012/13	53.1		951.9	1,600.7	1,314.7	4,430.9	325.5
2013/14	55.4	191.2	1,084.9	1,461.0	1,183.4	3,761.1	275.9
2014/15	51.5	161.3	963.8	1,620.4	1,223.1	1,892.0	368.5
2015/16	50.6	191.5	950.0	1,528.8	1,517.7	2,562.4	453.9
2016/17	48.2	161.1	933.3	1,776.0	1,352.8		374.6
2017/18	53.8	112.2	1,030.9		1,349.7		409.2

[a] Surveys conducted in spring.
[b] Number of breeding pairs.
[c] Lincoln estimates of adults.
[d] Fall-winter indices.

Table D.1. Continued.

Year	Rocky Mountain[a]	Pacific[a]	Dusky[a]	Cackling[d]	Lesser[a]	Taverner's[a]	Aleutian[d]
1969/70	29.1				12.7		
1970/71	47.2				8.2		
1971/72	26.7				3.4		
1972/73	28.6				6.4		
1973/74	32.4				21.2		
1974/75	31.6				6.9		0.8
1975/76	20.1				3.0		0.9
1976/77	19.6				4.7		1.3
1977/78	28.6				6.9		1.5
1978/79	43.5				6.5		1.6
1979/80	24.2				12.9		1.7
1980/81	47.8				18.4		2.0
1981/82	47.8				16.0		2.7
1982/83	30.7				3.4		3.5
1983/84	32.7				13.8		3.8
1984/85	35.3			47.8	9.6		4.2
1985/86	51.1		16.8	46.2	6.7	66.2	4.3
1986/87	50.1		15.5	68.2	4.6	47.8	5.0
1987/88	78.4		15.7	83.7	6.8	50.2	5.4
1988/89	74.1		17.1	87.2	7.1	48.3	5.8
1989/90	69.6		16.0	108.7	11.7	53.4	6.3
1990/91	63.3		10.7	98.7	4.3	76.9	7.0
1991/92	79.3		17.6	151.8	9.1	76.4	7.7
1992/93	89.4		16.4	156.6	5.9	49.3	11.7
1993/94	119.0		16.2	222.6	16.7	56.7	15.7
1994/95	118.3		12.0	239.2	9.6	49.5	19.2
1995/96	126.8		11.8	255.3	7.7	66.6	15.5
1996/97	85.0		13.3	301.3	5.0	61.3	20.4
1997/98	137.8		14.3	221.1	5.7	57.2	32.4
1998/99	99.1		10.3	247.0	5.7	63.8	35.3
1999/00	165.1		10.1	256.7	9.3	52.8	34.2
2000/01	161.4		11.0	258.8	6.1	55.5	88.3
2001/02	134.7		12.2	171.8	4.9	38.7	65.2
2002/03	134.3		9.7	239.1	6.3	52.8	73.0
2003/04	152.5		11.0	175.9	6.3	43.4	111.1
2004/05	151.8		15.9	224.1	4.8	44.3	87.8
2005/06	130.7		11.9	246.4	4.2	44.5	97.2
2006/07	137.2		10.1	253.8	9.5	57.2	117.3
2007/08	205.6		9.0	289.8	10.3	51.3	116.1

Table D.1. Continued.

Year	Rocky Mountain[a]	Pacific[a]	Dusky[a]	Cackling[d]	Lesser[a]	Taverner's[a]	Aleutian[d]
2008/09	118.4		6.6	230.8	6.4	49.7	81.8
2009/10	137.3	209.5	9.4	281.3	6.8	56.7	106.7
2010/11	98.1	267.6	11.6	184.1	3.6	36.1	105.3
2011/12	137.0	286.3	13.5	206.7	3.8	46.6	135.9
2012/13	153.2	311.9	0.0	319.0	4.1	27.3	166.3
2013/14	111.3	229.6	15.4	287.4	2.3	48.4	150.0
2014/15	158.2	329.0	17.7	347.1	4.0	32.8	197.7
2015/16	251.6	312.7	13.2	327.5	6.5	54.9	154.7
2016/17	187.7	297.9	13.5	289.9	2.8	45.7	168.5
2017/18	252.7	350.7	10.8	203.7	2.0	45.9	171.3

[a] Surveys conducted in spring.
[b] Breeding pairs.
[c] Lincoln estimate.
[d] Fall-winter indices

Table D.2. Abundance indices (in thousands) for snow, Ross's, white-fronted, and emperor goose populations, 1969–2018.

	Snow and Ross's geese					White-fronted geese		
Year	Ross's goose[a]	Mid-continent[c]	Pacific Flyway[b]	Wrangel Island[a]	Greater snow geese[a]	Pacific[b]	Mid-continent[b]	Emperor geese[a]
1969/70		1,283.0			89.6			
1970/71		1,266.3			123.3			
1971/72		1,120.7			134.8			
1972/73		1,282.5			143.0			
1973/74		1,960.1			165.0			
1974/75		1,151.6		56.0	153.8			
1975/76		1,352.1		58.0	165.6			
1976/77		2,051.2		68.2	160.0			
1977/78		2,346.2		65.4	192.6			
1978/79		1,793.0		84.5	170.1			
1979/80		1,855.4	528.1	90.7	180.0			
1980/81		1,567.7	204.2	89.0	170.8			
1981/82		1,898.9	759.9	100.0	163.0			
1982/83		2,089.1	354.1	95.0	185.0			
1983/84		2,098.7	547.6	85.0	225.4			
1984/85		2,216.8	466.3	85.0	260.0	163.2		19.8
1985/86		3,270.4	549.8	90.0	303.5	141.9		12.4
1986/87		1,606.6	521.7	100.0	255.0	140.0		13.0
1987/88		2,385.1	525.3	80.0	363.8	186.7		16.4
1988/89		3,916.1	441.0	70.0	363.2	198.1		16.9
1989/90		3,308.4	463.9	60.0	368.3	220.0		17.3
1990/91		2,732.3	708.5	60.0	352.6	196.5		14.9
1991/92		3,537.8	690.1	70.0	448.1	218.8		15.4
1992/93	201.9	3,779.0	639.3	65.0	498.4	234.1	622.9	17.1
1993/94	160.8	7,150.6	569.2	70.0	591.4	258.9	676.3	18.7
1994/95	150.7	4,483.6	478.2	65.0	616.6	302.2	727.3	18.8
1995/96	240.5	6,271.6	501.4	75.0	669.1	374.6	1,129.4	24.4
1996/97	220.6	12,330.5	366.3	85.0	657.5	370.5	742.5	23.3
1997/98	293.3	8,859.5	416.4	90.0	836.6	388.0	622.2	21.7
1998/99	391.7	11,423.6	354.3	90.0	1,008.0	393.4	1,058.3	21.4
1999/00	347.1	13,936.7	579.0	95.0	816.5	352.7	963.1	18.7
2000/01	467.8	13,816.3	656.8	105.0	837.4	438.9	1,067.6	27.3
2001/02	359.7	13,219.6	448.2	110.0	725.0	359.7	712.3	19.5
2002/03	517.5	9,497.2	596.8	115.0	721.0	422.0	669.7	21.4
2003/04	463.3	12,906.0	587.8	117.5	890.0	374.9	528.2	21.4
2004/05	563.7	11,553.2	750.3	117.5	880.0	443.9	644.3	19.8
2005/06	543.9	11,981.2	710.7	132.5	938.0	509.3	522.8	26.6
2006/07	718.9	16,202.2	799.7	140.0	838.0	604.7	751.3	24.4
2007/08	741.0	14,094.7	1,073.5	140.0	718.0	627.0	764.3	22.1
2008/09	669.2	14,800.0	957.4	132.5	1,009.0	536.7	751.7	20.7
2009/10	704.1	8,815.0	901.0	150.0	824.0	649.8	583.2	20.2
2010/11	665.1	13,790.4	863.8	155.0	917.0	604.3	709.8	21.2
2011/12	784.0	13,825.0	1,097.9		1,005.0	664.2	685.7	20.4
2012/13	555.1	13,976.8	881.4	160.0	921.0	579.9	777.9	29.8
2013/14	665.4	13,363.8	1,351.2		796.0	637.2		32.6
2014/15	613.8	9,248.2	1,199.6	240.0	818.0	479.1	1,005.6	26.2

Table D.2. continued.

	Snow and Ross's geese					White-fronted geese		
Year	Ross's goose[a]	Mid-continent[c]	Pacific Flyway[b]	Wrangel Island[a]	Greater snow geese[a]	Pacific[b]	Mid-continent[b]	Emperor geese[a]
2015/16	624.1	11,912.5		300.0	915.0	685.5	977.1	34.1
2016/17	446.6		1,906.8	346.0	747.0	735.6	1,000.1	30.1
2017/18				306.0	877.0	590.0	771.6	30.1

[a] Surveys conducted in spring.
[b] Fall-winter indices.
[c] Lincoln estimates of adults.

Table D.3. Abundance indices (in thousands) of North American brant and swan populations, 1969–2017.

	Brant		Tundra swans	
Year	Atlantic[a]	Pacific[a]	Western[b]	Eastern[a]
1969/70	106.5	141.7		
1970/71	151.0	149.2		
1971/72	73.3	124.8		
1972/73	40.8	125.0		
1973/74	88.1	130.7		
1974/75	88.4	123.4		
1975/76	127.0	122.0		
1976/77	73.8	147.0		
1977/78	46.7	162.9		
1978/79	42.0	129.4		
1979/80	59.2	146.4		60.1
1980/81	97.0	197.5		93.0
1981/82	104.5	121.0		73.2
1982/83	123.5	109.3		87.5
1983/84	127.3	135.0		81.4
1984/85	146.3	145.1	100.6	96.9
1985/86	110.4	134.2	73.3	90.9
1986/87	109.4	110.9	80.4	95.8
1987/88	131.2	145.0	84.4	78.7
1988/89	137.9	135.6	108.7	91.3
1989/90	135.4	151.7	114.8	90.6
1990/91	147.7	132.7	85.8	98.2
1991/92	184.8	117.8	73.5	113.0
1992/93	100.6	125.0	80.2	78.2
1993/94	157.2	129.3	84.1	84.8
1994/95	148.2	133.5	120.5	85.1
1995/96	105.9	128.0	110.6	79.5
1996/97	129.1	155.3	115.2	92.4
1997/98	138.0	138.8	126.8	100.6
1998/99	171.6	132.3	121.5	111.0
1999/00	157.2	135.6	110.5	115.3
2000/01	145.3	126.0	96.5	98.4
2001/02	181.6	138.2	118.9	114.7
2002/03	164.5	106.1	96.6	111.7
2003/04	129.6	121.3	112.6	110.8
2004/05	123.2	107.2	122.9	72.5
2005/06	146.6	141.0	124.7	81.3
2006/07	150.6	130.6	155.6	114.4
2007/08	161.6	157.0	174.4	96.2
2008/09	151.3		108.4	100.2
2009/10	139.4	163.5	111.6	97.3
2010/11	148.9	162.5	124.0	97.6
2011/12	149.2	177.3	115.3	111.7

Table D.3. continued.

	Brant		Tundra swans	
Year	Atlantic[a]	Pacific[a]	Western[b]	Eastern[a]
2012/13	111.8	163.3	110.4	107.1
2013/14	132.9	173.3	89.2	105.0
2014/15	111.4	136.5	129.1	117.1
2015/16	157.9	140.0	116.3	113.6
2016/17	161.7	155.7	131.6	119.3
2017/18	169.7	123.6	152.1	111.6

[a] Fall-winter indices.
[b] Surveys conducted in spring.

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