MANAGEMENT GUIDELINES FOR THE MID-CONTINENT POPULATION OF SANDHILL CRANES

Compiled by the:

Central Flyway Webless Migratory Game Bird Technical Committee

Prepared for the:

Central Flyway Council
Mississippi Flyway Council
Pacific Flyway Council
U.S. Fish and Wildlife Service

July 1981
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Revised March 1993
Revised March 2006
Revised March 2018

MANAGEMENT GUIDELINES OF THE CENTRAL, MISSISSIPPI, AND PACIFIC FLYWAYS FOR THE MID-CONTINENT POPULATION OF SANDHILL CRANES

These guidelines were prepared by the Central Flyway Webless Migratory Game Bird Technical Committee of the Central Flyway Council.

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FOREWORD

Original guidelines for the cooperative management of the mid-continent population (MCP) of sandhill cranes were adopted unanimously by the Central Flyway Council in official session at Billings, Montana, on July 30, 1981. The Council recommended that such guidelines be dynamic and these guidelines include provision for periodic review and revision, as necessary, to take advantage of new and improved information, to adapt to changing circumstances, and/or to accommodate new and changing intentions and desires.

In 1993, the Central Flyway Council recommended that the Pacific Flyway Council jointly adopt revised guidelines for the MCP of sandhill cranes. The revised cooperative management plan incorporates comprehensive biological information available for inter-flyway management of these cranes and reflected new information available on crane biology and management since 1981. It was subsequently signed by the Central and Pacific Flyway Councils during their spring meetings in 1993.

In 2005, MCP sandhill cranes that were tagged with radio and satellite telemetry equipment in the Central Platte River Valley of Nebraska were observed breeding in northwestern Minnesota. Therefore, it was recommended the Mississippi Flyway Waterfowl Council also be involved in the cooperative management of this population of sandhill cranes. Subsequently, the 2006 revision was later approved by the Central, Pacific, and Mississippi Flyway Councils in spring of that year.

MCP sandhill cranes migrate into or through many jurisdictions in at least four nations. They are of great interest to many individuals and organizations. The Central, Mississippi, and Pacific Flyway Councils solicit the cooperation of all who are responsible for or interested in the management of the international resource these great birds comprise. Inquiries or comments may be addressed to:

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MANAGEMENT GUIDELINES FOR THE MID-CONTINENT POPULATION OF SANDHILL CRANES

INTRODUCTION

Guidelines for the cooperative management of the mid-continent population of sandhill cranes (hereafter MCP) are outlined within this plan. The breeding and wintering ranges of the MCP cranes are extensive, spanning across multiple countries and continents (North America and Asia; Figure 1). During the breeding season, MCP cranes are widely scattered from eastern Siberia to Alaska, and from northern Canada to northwestern Minnesota (Figure 1). Fall migration routes include areas where large numbers of MCP cranes stage in Alberta, Saskatchewan, Manitoba, North Dakota, and Kansas (Krapu et al. 2011). Other fall staging areas are located in northwestern Minnesota, South Dakota, Oklahoma, and eastern portions of Colorado, Montana, and Wyoming. Following fall migration, MCP cranes spend the late-autumn and winter months in Oklahoma, Texas, New Mexico, southern Arizona, and also northern Mexico, primarily in the states of Chihuahua, Durango, and Tamaulipas (Krapu et al. 2011, Lopez-Saut et al. 2011). During late February to early April each year, the majority of individuals in the MCP are among the spectacular numbers of migratory birds which stage in the north and central Platte River Valleys of Nebraska.

In 2016 the genus *Antigone* was split from *Grus* to become the new genus for sandhill cranes, along with three other species of cranes worldwide. Historically, three subspecies were recognized within the MCP: lesser (*Antigone canadensis canadensis*), Canadian (*A. c. rowani*), and greater (*A. c. tabida*) based on differences in morphometrics and breeding ranges (Walkinshaw 1973, Johnson and Stewart 1973, Guthery and Lewis 1979). However, genetic studies using mitochondrial DNA (Rhymer et al. 2001, Glenn et al. 2002, Peterson et al. 2003, Jones et al. 2005) suggested only two subspecies occur in the MCP: lesser and greater sandhill cranes. Tacha et al. (1984, 1985, 1992) suggested the MCP be managed as two subpopulations: eastern (or Gulf Coast) and western. Based on more recent satellite telemetry studies, Krapu et al. (2011, 2014) suggests there are four MCP breeding affiliations: Western Alaska-Siberia, northern Canada-Nunavut, West-central Canada-Alaska, and East-central Canada/Minnesota (Figures 1 and 2; Appendix A).

We have carefully considered management strategies of the MCP in light of several criteria: the definition of a subpopulation, the potential need to differentially manage subpopulations, and the feasibility in managing individual subpopulations. Based on current understanding and management constraints, the Flyway Councils (*hereafter* Councils) are reluctant to use the term subpopulation when managing the MCP. Instead "breeding affiliations" will be referred to, which are defined as groups of birds that nest in discrete areas and are largely composed of the same subspecies according to mitochondrial DNA (Krapu et al. 2011, 2014).

The Councils believe that differential management of breeding affiliations may be warranted if one or more population parameters differ among breeding affiliations: 1) population trends, 2) recruitment rates, 3) harvest rates, and 4) harvest pressure (i.e., spatiotemporal exposures to

hunting). Although evidence exists that breeding affiliations may have different recruitment rates and harvest pressure (Krapu et al. 2014), operational monitoring programs have not been developed to assess whether differences in demographic rates justify separate, informed management strategies for the breeding affiliations. Thus, the MCP will continue to be managed as a single population with more restrictive regulations in eastern zones (i.e. Unit 2 in North Dakota and Zone C in Texas) designed to reduce harvest of less numerous greater sandhill cranes until population and harvest parameters can be monitored independently at a breeding affiliation level.

GOAL

The management goal is to provide diverse aesthetic, educational, scientific, recreational, and consumptive public uses that are consistent with the welfare of the MCP, international treaties, and socio-economic constraints such as depredation of agricultural crops.

POPULATION GUIDELINES

Objective A: Maintaining a 3-year average population index within a range of 350,000 - 475,000 MCP cranes. The average of the three most recent and reliable photo-corrected annual spring surveys along the Platte River of Nebraska will be used to evaluate current population status within these thresholds.

Rationale: The population objective was calculated by taking ±15% of the 1982 - 2005 average of approximately 411,000 cranes estimated from photo-corrected ocular transect surveys along the Platte River in Nebraska and rounded up to the nearest 5,000 birds (Figure 3). Plotting this 3-year running average of the population index shows an objective well within or above the threshold limits of 350,000 - 475,000 birds for over 30 years (Figure 4). The number of individuals in the MCP that occurred during 1982-2005 was abundant enough to fulfill subsistence, recreational (hunting and non-hunting), and other interests and will continue to be used to guide population objectives for the near future. Problems associated with crop depredations continued during this time, but at manageable levels. We do not intend to liberalize hunting regulations when the population is above objective, but if increases in abundance results in more depredation and/or other complaints, additional take could be biologically justified to help alleviate these problems if necessary.

Strategy A-1: Monitor the population and harvest status of the MCP:

a. Obtain an annual index of the MCP through coordinated surveys in late March in specific Central Flyway states. This will include an annual photo-corrected aerial transect survey (ocular transect survey) with design and coverage comparable to that initiated in 1982 (Figure 3), and ground or aerial surveys in locations outside of the Platte River region, indicated by either sightings or radio tagged sandhill cranes from research projects. The 3-year average of ocular transect surveys will be used to determine current population status.

b. The ocular transect survey will take place each year between March 22-26. The pilot biologist responsible for conducting the survey will select the most feasible weekday within these dates to conduct the annual survey (see appendix A for survey dates and coinciding weekdays). A survey date should be selected by March 1st each year and all states responsible for ground counts should be notified promptly. Alternatively, it can be determined by flyway biologists (state and federal) prior to the survey period that a more appropriate survey date falls outside of the standard survey period based on current year spring migration chronology. In such cases, a majority consensus among flyway biologist is needed by March 10th to proceed with the desired survey date.

c. A 90% threshold will be used to determine reliability of annual surveys when calculating the 3-year average. If the ocular transect survey estimate accounts for at least 90% of the MCP when compared with ground or aerial surveys outside of the Platte River Valley region in a given year, the survey is considered reliable (i.e., "good") and will be used in the calculation of the 3-year average. Additional ground or aerial surveys conducted concurrently with the annual ocular transect survey will be used to determine the percentage of cranes accounted for in the following states: Texas, Oklahoma, Kansas, Wyoming, and areas of Nebraska that are not part of the ocular transect survey. The states of New Mexico and/or Colorado could begin spring surveys at any time if substantial numbers of cranes are not being accounted for during annual monitoring in these states. The states of South Dakota and North Dakota will continue to conduct surveys for over flight monitoring purposes, but cranes recorded in these states will not be included in the totals for survey areas outside the Platte River Valley. Only the three most recent "reliable" annual ocular transect surveys will be used to calculate the 3-year average.

d. Continue efforts to identify and address potential biases in survey results in order to improve population estimates. Some potential sources of this bias include: 1) the timing of the ocular transect survey in relation to the migration chronology of the cranes, 2) habitat changes that may affect the proportion of the MCP that stage in the central Platte River Valley, 3) the proportion of the central Platte River cranes not on the ocular transect survey area while the survey is being conducted and 4) unknown changes within the survey (e.g., flock size, distributional changes among transects).

e. Evaluate alternative population estimators or methodologies if there appears to be more feasible and suitable methods emerging.

f. Produce accurate/precise harvest estimates by USFWS and CWS at a high sampling rate (~26%). State wildlife agencies need to implement measures to ensure accurate sampling frames are available to the USFWS.

g. Continue to include sandhill cranes in USFWS waterfowl breeding ground surveys in Alaska and Yukon-Kuskokwim goose plots (Table C-8).

Rationale: Reliable data on the status and trend of the MCP are essential for effective management of the population. The coordinated, annual spring surveys have been improved through statistically valid sampling procedures that include photo-correction of ocular estimates from the Platte River Valley in Nebraska where the majority of the population occurs during late March. These annual estimates are expected to provide reasonable indicators of trends in the MCP.

The exact number of individuals in the MCP is unknown. The population has been monitored using surveys in late March since 1957 in Nebraska, and since 1974 throughout the Central Flyway (Table 1). In 1982 high-altitude vertical photography of the central Platte Valley of Nebraska resulted in an estimate of a minimum 510,000 cranes in the population. Since 1982, surveys for cranes have not used high altitude vertical photography to estimate the size of the MCP, but have relied upon photo-corrected ocular transects to estimate population status. In March 1990, a 3-year average derived from annual, photo-corrected ocular transect surveys replaced high altitude vertical photography as the primary measure for monitoring population status. The use of 3-year averages helps to mitigate annual sampling variation in the ocular transect survey estimates. Analysis of these averages suggests a stable to increasing population trend for the MCP (Figures 3 and 4). Recent surveys of MCP sandhill cranes in northwest Minnesota were also conducted from 2012-2016 and indicate a stable breeding population in this region (Lawrence et al. 2016). However, performing large scale breeding surveys over the vast MCP range is not feasible at this time.

It is generally assumed that the annual ocular transect survey for cranes is reliable if the photo-corrected estimate represents at least 90% of total cranes counted (i.e., photo-corrected counts in Nebraska plus ground counts in other states) during the survey that year. Since 1982, the proportion of cranes detected on the Platte River on the survey date fell below 90% a total of five times, but never occurred two years in a row (Table 1). However, during a 7-year study (2001-2007), on average only 86% of marked cranes were present along the Platte River during scheduled survey dates (Pearse et al. 2015). In addition, annual changes in the index appear to have exceeded biologically plausible changes in population size in over 50% of the surveys since 1982, raising questions about variation in migration chronology and survey timing (Pearse et al. 2015). However, late March continues to be the most appropriate time to survey cranes along the Platte River as it generally coincides with the greatest numbers being present, along with the lowest annual variation during spring migration (Pearse et al. 2015). Ground or aerial surveys conducted concurrently with the annual ocular transect survey in areas outside of the Platte River region are used to qualitatively assess the extent to which MCP cranes may not be captured by the ocular transect survey. Though these supplemental surveys are not conducted according to a statistical design and may be somewhat inconsistent across the region, they can detect substantial numbers of additional birds and are used to gauge the reliability of the annual photo-corrected ocular transect survey.

Responsibilities: U.S. Fish and Wildlife Service (a, b, c, d, e, f, and g), cooperating agencies in Central Flyway States (a, b, c, d, e, and f), Canadian Wildlife Service (f), and Alaska Department of Fish and Game (f).

Strategy A-2: Continue current management of refuges and wildlife management areas, disease control, and other management programs which may affect sandhill cranes as long as the population index (latest 3-year running average) falls within the 350,000 to 475,000 objective range.

Rationale: The available information indicates that MCP cranes have remained within or above the objective population range in recent years. Wildlife management agencies will guard against any action, or inaction, which would substantially decrease the population size of the MCP below the objective population range.

Responsibilities: All cooperating agencies. Flyway technical committees, Councils, and USFWS will monitor on-going programs and develop recommendations for changes in management programs not consistent with this objective.

Strategy A-3: Maintain sufficient breeding, staging, and wintering habitat to support the population at the population objective. Discourage actions and programs that may degrade or decrease critical habitats used by the MCP. Emphasis will be on information and education programs demonstrating the value of key wildlife habitats and in identifying alternate sites where proposed developments may negatively impact MCP cranes.

Rationale: Breeding habitat is considered to be generally adequate to abundant; however, there are significant threats to some breeding, migration, and wintering habitats. Of particular concern are periodic low flows in the Platte River (Eschner et al. 1983). Additional threats to the Platte River include past channelization, flood control, woody vegetation growth within the channel (Johnson 1994, 1997), invasive species (Kessler et al. 2013, Galatowitsch et al. 2016), and energy infrastructure including powerlines. Also, decreases in available waste-corn in the Central Platte River Valley during the past 20 years has been observed due to increases in harvest efficiency, increasing numbers of geese in the region, and expanding soybean production (Krapu et al. 2004, 2005, Pearse et al. 2017). Habitat on fall staging areas in Saskatchewan and North Dakota is being impacted by wind energy and by oil and gas development in the Bakken region. On the wintering grounds in Texas, New Mexico, and Oklahoma, playa and saline pluvial wetlands face a number of threats including groundwater loss, hydrological alterations, mining, and oil and gas exploration. In particular, the number of unaltered saline pluvial wetlands is limited. The loss or degradation of any of these seasonal habitats utilized throughout the annual cycle may negatively impact MCP recruitment and/or survival.

Responsibilities: All cooperating agencies.

Strategy A-4: Determine potential cause(s) of local or regional non-hunting mortality and make appropriate adjustments in management programs for the MCP to avoid or reduce non-hunting mortality.

Rationale: Overall non-hunting mortality is relatively low, but occasional, highly visible local or regional non-hunting mortality occurs and should be addressed. Sources of non-hunting mortality may include but are not limited to: disease outbreaks, excessive predation, transmission line or tower strikes, and poaching incidents.

Responsibilities: All cooperating agencies. Flyway technical committees, USFWS, and CWS will monitor the population and develop guidelines for necessary changes in management programs.

Strategy A-5: Modify hunting opportunities to maintain the MCP within the population index objectives (see Objective C).

Rationale: Manipulating harvest is a strategy available for managing the population size of MCP cranes. However, several factors will affect the rate of change in the population, including harvest rates and the magnitude of non-hunting mortality.

Responsibilities: All cooperating agencies.

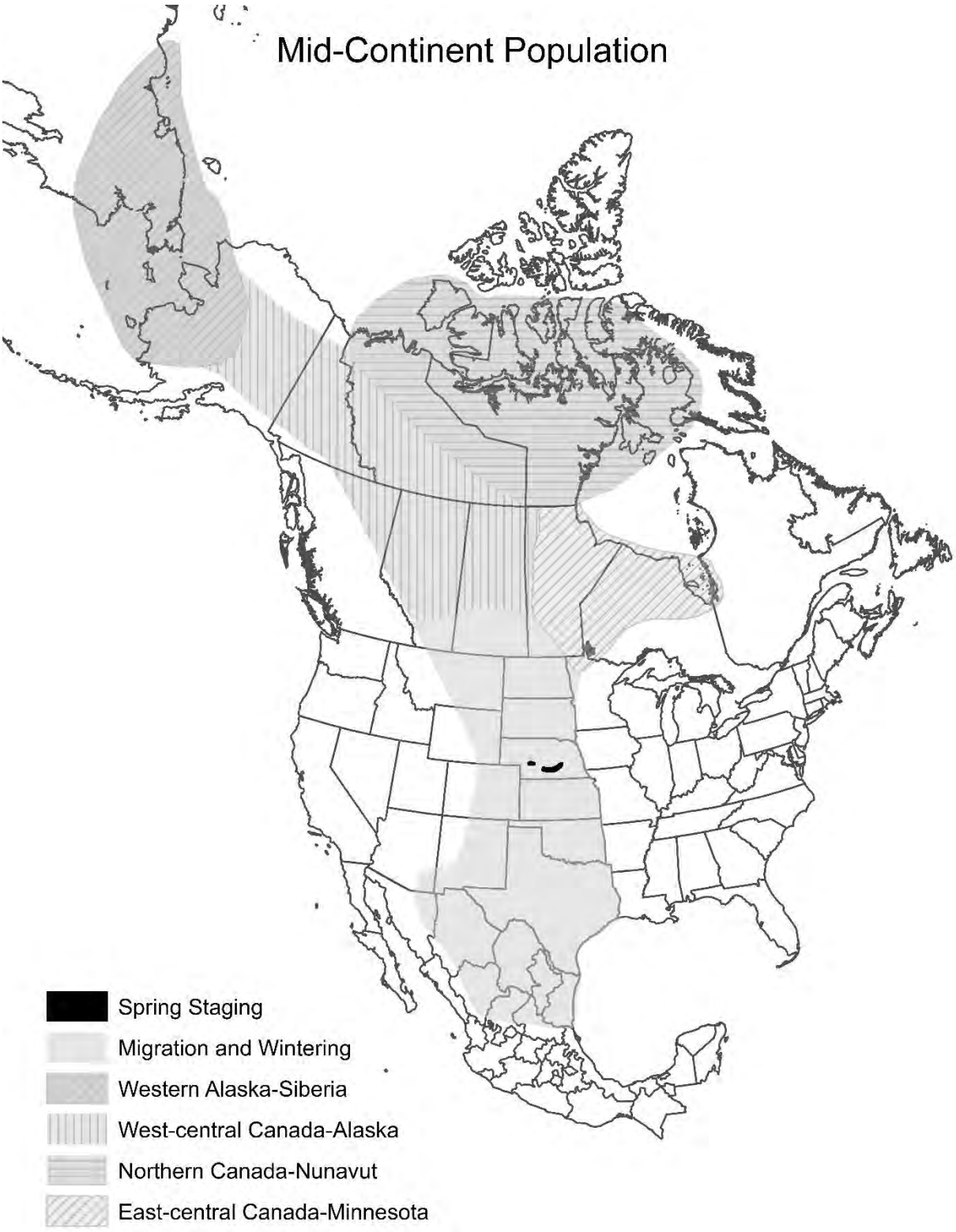

Figure 1. Approximate range of mid-continent sandhill cranes and its four breeding affiliations associated with this population (based on figures in Tacha et al. 1994, Krapu et al. 2011, and Gerber et al. 2014).

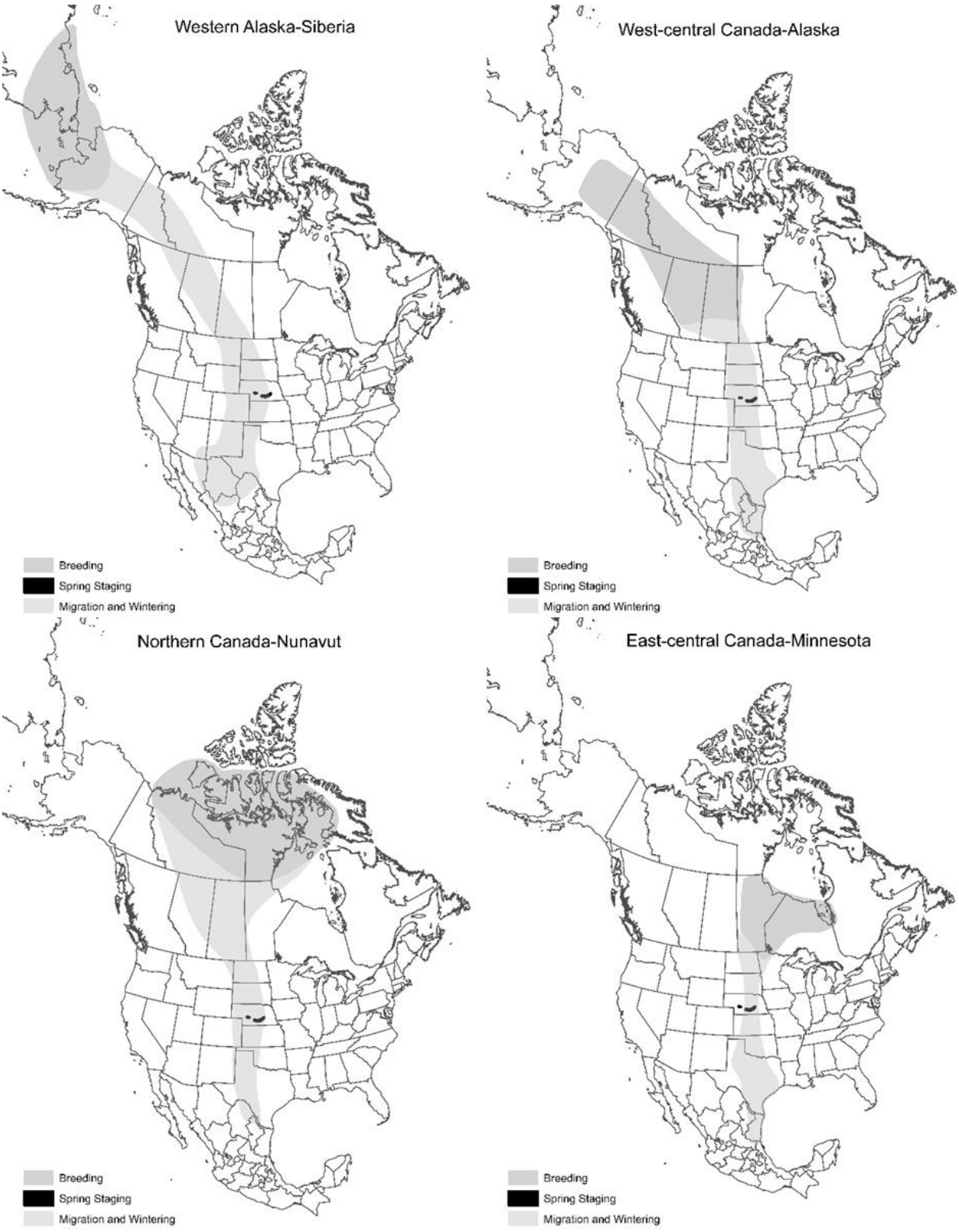

Figure 2. Approximate ranges of the four breeding affiliations of mid-continent sandhill cranes recognized by Krapu et al. 2011, 2014.

Table 1. Annual spring population indices for the mid-continent population of sandhill cranes (Dubovsky 2017).

	Central Platte River Valley, NE					Other							All Areas			
	Ocular Cruise	Ocular	Photo Corrected Ocular Transect			Other							Ocular Cruise	Ocular	Photo Corrected Ocular Transect	
Year	Transect	Transect	Annual	Proportion[1]	3-Yr Avg	NE	KS	TX	CO[2]	OK[2,3]	NM[2]	WY[3]	Transect	Transect	Annual	3-Yr Avg
1974	162,600	-	-	-	-	9,000	1,900	3,200	0	400	0	-	177,100	-	-	-
1975	223,600	-	-	-	-	2,300	900	tr	500	100	100	-	227,500	-	-	-
1976	147,500	-	-	-	-	2,800	300	800	0	100	1,000	-	152,500	-	-	-
1977	173,400	-	-	-	-	1,100	1,600	30,700	0	400	12,500	-	220,000	-	-	-
1978	149,800	188,582	-	-	-	2,200	700	4,900	0	0	2,300	-	159,900	198,682	-	-
1979	-	203,574	-	-	-	2,600	1,100	0	500	1,500	0	-	-	209,274	-	-
1980	223,400	254,417	-	-	-	5,000	4,100	1,400	0	100	500	-	234,500	265,517	-	-
1981	-	248,882	-	-	-	8,300	11,200	21,800	500	0	0	-	-	290,682	-	-
1982	-	347,996	417,263	(95%)	-	7,100	2,000	7,800	2,800	0	100	-	-	367,796	437,063	-
1983	-	306,316	343,378	(97%)	-	4,100	200	7,000	0	200	tr	-	-	317,816	354,878	-
1984	-	222,710	261,802	(93%)	340,814	18,100	900	800	0	1,100	tr	-	-	243,610	282,702	358,214
1985	-	378,127	514,763	(97%)	373,314	11,500	3,000	1,200	-	-	-	-	-	393,827	530,463	389,348
1986	-	317,025	353,040	(99%)	376,535	1,000	200	2,100	-	-	-	-	-	320,325	356,340	389,835
1987	-	383,581	416,058	(100%)	427,954	0	tr	400	-	-	-	-	-	383,981	416,458	434,420
1988	-	386,853	463,457	(98%)	410,852	0	0	7,700	-	-	-	-	-	394,553	471,157	414,652
1989	-	391,353	391,995	(100%)	423,837	100	1,000	800	-	-	-	-	-	393,253	393,895	427,170
1990	-	385,950	412,154	(94%)	422,535	11,000	5,200	10,300	-	-	-	-	-	412,450	438,654	434,569
1991	-	297,831	340,645	(100%)	381,598	100	800	200	-	-	-	-	-	298,931	341,745	391,431
1992	-	257,709	406,457	(97%)	386,419	12,200	300	1,100	-	-	-	-	-	271,309	420,057	400,152
1993	-	253,799	378,883	(85%)	375,328	16,800	37,750	13,500	-	-	-	-	-	321,849	446,933	402,912
1994	-	395,543	477,215	(97%)	420,852	14,600	0	0	2,400	-	-	-	-	410,143	491,815	452,935
1995	-	273,376	326,181	(91%)	394,093	30,400	0	0	6,700	-	-	-	-	303,776	356,581	431,776
1996	-	318,514	519,984	(99%)	441,127	7,600	0	0	3,900	-	-	-	-	326,114	527,584	458,660
1997	-	350,932	534,630	(97%)	460,265	16,200	100	0	-	-	-	-	-	367,232	550,930	478,365
1998	-	337,203	530,848	(97%)	528,487	13,600	100	0	-	-	-	-	-	350,903	544,548	541,021
1999	-	219,794	284,858	(73%)	450,112	3,500	100,000	0	-	-	-	-	-	323,294	388,358	494,612
2000	-	484,585	490,118	(92%)	435,275	16,900	26,100	500	-	-	-	-	-	528,085	533,618	488,841
2001	-	387,336	413,498	(88%)	396,158	10,500	42,300	3,500	-	-	-	-	-	443,636	469,798	463,925
2002	-	309,029	315,044	(90%)	406,220	17,100	15,100	1,200	-	5,800	-	-	-	342,429	348,444	450,620
2003	-	300,918	348,023	(91%)	358,855	24,800	4,100	3,800	-	-	-	-	-	333,618	380,723	399,655
2004	-	365,370	426,534	(95%)	363,200	17,700	1,200	2,200	-	100	-	-	-	386,470	447,634	392,267
2005	-	412,285	491,915	(93%)	422,157	27,100	2,900	8,700	-	2,600	-	-	-	450,985	530,615	452,991
2006	-	178,564	216,810	(74%)	378,420	70,000	2,100	5,500	-	-	-	-	-	256,164	294,410	424,220
2007	-	307,094	384,118	(93%)	364,281	20,400	3,600	5,900	-	-	-	-	-	336,994	414,018	413,014
2008	-	474,051	545,884	(96%)	382,271	24,500	1,100	0	-	-	-	-	-	499,651	571,484	426,637
2009	-	457,436	565,257	(93%)	498,420	29,900	tr	10,800	-	-	-	-	-	498,136	605,957	530,486
2010	-	455,104	691,534	(94%)	600,892	17,600	1,300	28,000	-	-	-	-	-	502,004	738,434	638,625
2011	-	347,501	482,797	(93%)	579,863	18,800	3,500	14,300	-	4,700	-	-	-	384,101	519,397	621,263
2012	-	253,783	339,642	(95%)	504,658	12,900	tr	4,200	-	-	-	-	-	270,883	356,742	538,191
2013	-	745,854	867,061	(97%)	563,167	16,080	279	9,740	-	1,800	-	-	-	771,953	893,160	589,766
2014	-	402,228	617,903	(94%)	608,202	24,390	5,996	7,534	-	239	-	2,952	-	440,148	655,823	635,242
2015	-	326,053	386,471	(85%)	623,812	24,545	4,479	37,121	-	2,195	-	2,918	-	392,198	452,616	667,200
2016	-	272,250	405,716	(94%)	470,030	11,218	261	16,500	-	175	-	4,200	-	300,229	433,695	514,045
2017	-	436,671	568,369	(95%)	453,519	18,674	180	9,193	-	16	-	3,255		464,718	596,416	494,242

[1] Proportion of total MCP index comprised of the corrected ocular transect (Photo Corrected Ocular Transect/Photo Corrected Ocular Transect + Other Areas).

[2] NM, CO, and OK were eliminated from the official survey area in 1985 by the CF CMU.

[3] Ok and WY were added to the official survey area in 2018 by the CFWMGBTC.

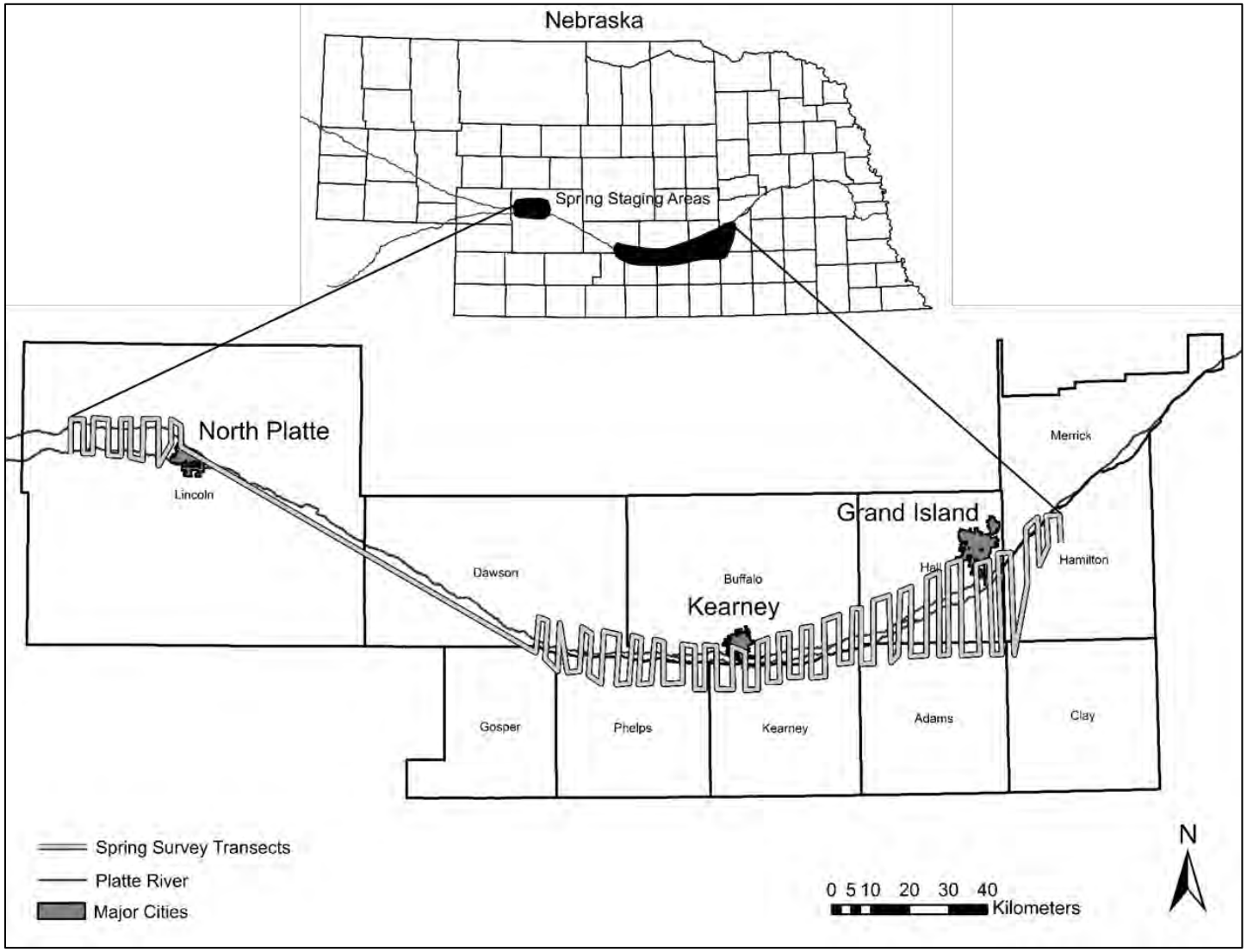

Figure 3. Spring staging areas and coinciding ocular transects used for the annual spring survey of the mid-continent population of sandhill cranes in the Platte River Valley of Nebraska.

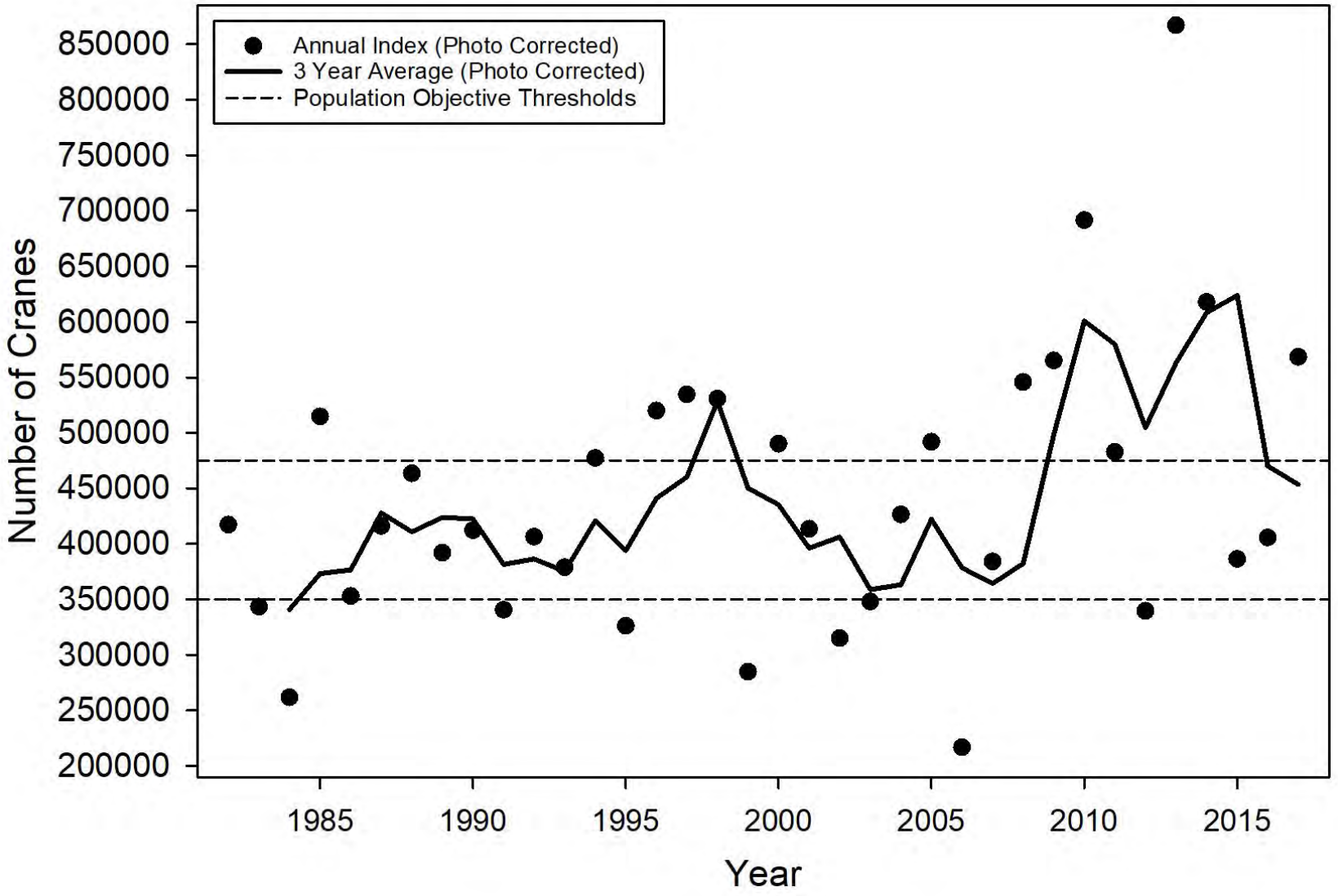

Figure 4. Annual and 3-year spring population indices and population objective thresholds for mid-continent sandhill cranes. Population indices are from photo-corrected aerial surveys along the Platte River of Nebraska. Thresholds are equal to the mean of surveys conducted between 1982-2005 ± 15%, rounded to the nearest 5 thousand birds.

DISTRIBUTION GUIDELINES

Objective B: Maintain the geographic and temporal distribution of MCP cranes similar to the 1982 - 2017 period.

Rationale: The current geographic and temporal distributions of MCP cranes are considered acceptable. There are no recognized adverse effects of the current distribution of the birds. MCP cranes are generally tolerated on the privately owned lands they occupy during substantial portions of each year. Use programs may be adjusted to assure satisfactory recreational opportunities within the current distributions.

Strategy B-1: Continue to maintain refuges, management areas, habitat protection, disease control and other wildlife management programs to benefit cranes. Proposed changes in management (for changes in hunting, see USE GUIDELINES) which may affect the distribution of MCP cranes will be assessed by the agency considering such changes and, if major impacts are probable, such proposals will be presented to the Flyway Councils for consideration.

Rationale: The current distributions of MCP cranes probably reflect the effects of agricultural land uses, roosting habitats, weather, and wildlife management programs. However, even minor changes in management programs could result in shifts that might affect programs in other areas and tolerance of MCP cranes on private lands. It is recognized that, other than managing habitats and hunting, management agencies have minimal control of crane distribution.

Responsibilities: All cooperating agencies. The Central, Mississippi, and Pacific Flyway technical committees will assess the potential impacts of proposed changes in management programs and develop recommendations for action.

Strategy B-2: Provide adequate habitats for MCP cranes during migration and wintering periods:

a. Identify changes in areas regularly used by cranes.

b. Encourage the preservation of publicly-owned habitats controlled by governmental agencies other than wildlife agencies.

c. Encourage the preservation of key habitats on private lands. Seek funds to assure the preservation of imminently threatened key habitats by lease, easement, fee title purchase and/or cooperative agreements (e.g., water rights) with special emphasis on major roosting sites in wintering areas (specifically playas and saline lakes) and roost sites and wet meadows within the Platte River Valley of Nebraska (e.g., maintaining flows in the Platte River).

d. Maintain open sandbar habitat along major spring staging areas of the Platte and North

Platte Rivers of Nebraska (usually only an issue during periods of low flows in the river, but conditions should continuously be monitored to determine proper course of action). Cooperating agencies (federal, state, non-profit) should work together to secure funding in order to mechanically clear vegetation or augment sedimentation during periods of low flows in the river.

Rationale: Habitat is a key factor affecting both the geographic and temporal distribution of MCP cranes. Losses and/or degradation of important habitats and changes in agricultural land uses in staging and wintering areas undoubtedly will affect current distributions. Changes in distribution on wintering areas may result in overcrowding that will affect the welfare of MCP cranes.

Responsibilities: U.S. Fish and Wildlife Service, Canadian Wildlife Service, and cooperating agencies in Alaska, Central and Mississippi Flyway States and Provinces, and Mexico. Programs that include cooperation with private landowners (e.g., Alaska Natives, First Nations of Canada, and agricultural producers) will be essential.

Strategy B-3: Minimize activities such as boating, blasting, drilling, and low-level flying that unnecessarily disturb MCP cranes using key staging and wintering areas. Emphasis will be on educational programs, direct appeals and regulations as appropriate.

Rationale: Major disturbances probably would alter the temporal and geographic distribution of MCP cranes. Additionally, there is concern that energetic balances will be negatively affected by excessive disturbances, potentially impacting survival and/or recruitment.

Responsibilities: All cooperating agencies.

Strategy B-4: Monitor MCP cranes in areas of known risk (e.g., where avian cholera is common, or areas where cranes are concentrated).

a. Consult the National Wildlife Health Center when losses to diseases are detected.

b. Initiate measures to discourage or disperse birds occurring in undesirable concentrations (e.g., that show effects of overcrowding) with emphasis on developing nearby alternative habitats.

Rationale: Any alteration of geographic or temporal distribution required for the welfare of MCP cranes will be considered consistent with this objective; however, any redistribution will be the minimum appropriate to the needs of Strategy B-4, and feasible to management agencies.

Responsibilities: All cooperating agencies.

USE GUIDELINES

Objective C: Maximize subsistence and consumptive recreational use consistent with population and distribution objectives.

Rational: MCP sandhill cranes are highly prized by consumptive and non-consumptive users throughout the Central, Mississippi, and Pacific Flyways. Both recreational and subsistence use of the MCP are key motivations for managing the MCP at or above Objective (A) levels. Managing the MCP at these levels will allow managers to maximize both recreational and subsistence use and enjoyment, while also limiting socio-economic conflicts such as agricultural crop depredation by MCP cranes.

Strategy C-1: Adjust hunting regulations within Migratory Bird Treaty Act frameworks to:

a. Permit hunting opportunities in all areas where MCP cranes regularly occur except areas closed by statutes or regulations. Current areas and federal frameworks for sandhill crane hunting in the U.S. and Canada can be found in Appendix A.

b. Attract hunters to areas where losses of agricultural crops have been verified and during the periods when depredations are likely to occur. Crop depredation was the reason for implementing hunting in the Central Flyway in 1961 and continues to be reported. For those producers still experiencing depredation problems outside of the hunting season they can apply for a federal migratory bird depredation permit. In such cases, the Councils encourage collection of data documenting losses (such as frequency, time period, number of cranes involved, crop types, acres affected, estimated and confirmed financial loss).

c. Maintain current harvest opportunities while the MCP is at Objective (A) levels. If the 3-year population average falls below the lower threshold (350,000 birds), harvest will be reduced according to thresholds established in Table 2. However, given the sometimes large variations in the annual spring index, harvest will not be reduced by these guidelines until the 3-year average falls below the lower objective level for three consecutive years. In such cases, the most recent 3-year average will be used to determine bag limit reductions according to population thresholds established in Table 2. If the 3-year average ever falls below 200,000 birds after being below objective (A) thresholds for three consecutive years, hunting seasons will be closed for MCP cranes in the United States. Similarly, the 3-year population index must remain above a higher threshold for three consecutive years in order for bag limits to increase again following a period of bag limit reductions. Canada will consider commensurate reductions in bag limits when applicable with their regulatory cycle.

Rationale: Based upon long-term regression of the photo-corrected spring population index on the Platte River since 1982, the MCP is stable to slightly increasing, while total estimated harvest has leveled off over the past decade (Figures 5 and 6). Decreases in the spring population index could be a concern because of drought and habitat threats on the Platte River

in Nebraska, and also in Canada and Texas. Conversely, increases may result in over-crowding and/or increased depredation of crops. Hunting is an important component of management of the MCP and may assist in alleviating depredations and high densities in undesirable locations. If feasible, states may also elect to alter season dates within federal frameworks to address issues in specific areas. .

Responsibilities: All cooperating agencies. Proposed changes in federal hunting regulation frameworks must be endorsed by the appropriate Council(s) prior to consideration by the U.S. Fish and Wildlife Service.

Strategy C-2: Assure reasonable protection for threatened and endangered species by:

a. Informing citizens of the need to protect such species, mostly whooping cranes.

b. Advising hunters of the possible occurrence of threatened and endangered species within areas open to hunting.

c. Implementing the Whooping Crane Contingency Plan when confirmed sightings of Aransas/Wood Buffalo whooping cranes occur in areas open to sandhill crane hunting.

d. Implement the Eastern and Louisiana Nonessential Experimental Population (NEP) Whooping Crane Memorandum of Understanding (MOU) if whooping cranes are identified to be part of this introduced populations.

Rationale: Information and education programs for hunters, the general public, and law enforcement will minimize the risk to threatened and endangered species. It is recognized that whooping cranes, especially during their first autumn, could be mistaken as sandhill cranes; however, close monitoring of whooping crane migration and, if necessary, temporary suspensions of hunting in the vicinity, will assure adequate protection of whooping cranes in areas open to sandhill crane hunting. Whooping cranes within the MCP's range are most likely from the Aransas/Wood Buffalo Population, but overlap with the experimental Eastern or Louisiana populations (releases starting in 2001 and 2013, respectively) are possible. If it can be determined which population an individual or group belongs to, then the strategy for dealing with them should differ. If an individual or group belongs to the Aransas/Wood Buffalo Population, then the Whooping Crane Contingency Plan (which may involve informal spot closures of hunting areas) should be implemented. If an individual or group belongs to the Eastern Population, then the processes detailed in the MOU (which may allow continued MCP crane hunting and involve relocation of the individual[s]) should be followed.

Responsibilities: All cooperating agencies.

Strategy C-3: Monitor the harvest of MCP cranes by:

a. Continuing and improving annual harvest surveys.

b. The CWS may consider providing improved recreational harvest estimates. Currently, CWS only requests information on total seasonal harvest within their waterfowl harvest surveys; thus, impacts of daily bag limits, etc. cannot be evaluated.

c. Consistent with objective A, the appropriate management scale, at this time, is still considered to be at the MCP as a whole, rather than at a breeding affiliation level.

d. Researchers will attempt to collect demographic and harvest information at a finer scale than the population level (i.e., breeding affiliations).

e. It is recommended that harvest surveys achieve a target precision goal for the U.S. portion of the MCP that do not exceed 10% of point estimates (95% CI) for harvest, hunters and days of hunting. The USFWS Harvest Surveys Section will determine current precision, constraints and costs to achieve target precision.

f. Improve harvest management through a less prescriptive harvest strategy into a more derived harvest strategy that accounts for species biology, abundance, and harvest.

g. Special permits in the U.S. portion of the Central Flyway will continue to be mandatory (as a sampling universe for postseason harvest surveys) until a suitable alternative is developed (e.g., electronic-based survey). However, the states and the USFWS will address declining response rates of voluntary hunter mail questionnaires and will evaluate and adjust estimates for any resulting non-response bias.

h. Continuation of the current USFWS species-specific harvest survey is highly recommended compared to a HIP-based survey. Recent problems (e.g., over-issuance of crane registrations, coding issues, etc.) still plague the current harvest survey, but harvest estimates on less frequently hunted species like cranes are currently too high (> ±50% of estimate, $\alpha = 0.1$) to measure response of harvest to subtle reductions in bag or season length that are needed in the harvest strategy.

i. Develop methods to reasonably estimate the subsistence take of MCP in Canada and Russia, and total harvest in Mexico.

Rationale: Annual harvest surveys are important in monitoring the distribution of harvest, hunter participation and success, and assuring maximum hunting opportunities in all parts of MCP range. Moreover, improving accuracy of harvest surveys is important in Canada where MCP harvest is increasing due to harvest liberalizations and increased interest by guides and outfitters, but only ~25% of crane hunters respond to surveys (Michel Gendron, CWS, personal communication). Harvest by hunters is the preferred method of stabilizing MCP abundance, but this must be monitored to assure that it is adequate and can be adjusted should the population fall below Objective (A) levels. A summary of MCP harvest in the Central Flyway is noted in Appendix C.

Response rates of voluntary hunter mail questionnaires in the U.S. have decreased, raising concerns about non-response bias. Average response rate among states has dropped from about 70% in 1980 to about 50% today (Robert Raftovich, USFWS, personal communication). The USFWS is taking steps to measure this bias and improve response rates by adding or changing questionnaire instructions and making periodic mailings throughout the hunting season. States harvesting sandhill cranes should provide more timely contact information which would allow more frequent mailings, possibly increasing response rates and reducing effects of 'memory bias' (Atwood 1959).

States must continue to take the lead by providing complete and accurate contact lists of crane hunter names and addresses in their respective states. Sampling problems such as over-issuance and coding issues still exist, thus, permits are issued to a large proportion of license applicants who may not have specifically requested it, resulting in non-response at higher rates than in the past or among other states with more accurate contact lists. The result is higher survey cost as more questionnaires must be mailed to achieve adequate sample sizes of active hunters. During periods of budgetary constraint, additional mailings may exceed available funds and, in essence, undermine the purpose of stratifying the sampling universe by permit issuance. In addition, there is the hidden cost of unknown bias in harvest estimates.

States agencies could focus permit acquisition on active crane hunters by either charging a nominal application fee, issuing the permit only from its offices, or by toll-free telephone number or internet. We believe that these measures would greatly reduce over-sampling and increase efficiency of the USFWS harvest survey.

Responsibilities: All cooperating agencies. The flyway technical committees, USFWS, and CWS will assist in developing appropriate strategies to adjust harvest rates should problems develop. The Councils welcome population modeling efforts by qualified biometricians including the USGS-BRD Patuxent, Northern Prairie Wildlife Research Center, and USFWS Division of Migratory Bird Management scientists to illustrate effects of harvest on population size, and effects of harvest regulations on total harvest.

Strategy C-4: Increase public opportunities, where feasible, to observe or photograph MCP cranes by:

a. Designate observation points at appropriate sites along public roads from which concentrations of MCP cranes can be observed.

b. Construct towers and/or blinds with screened access routes to overlook concentrations on public lands.

c. Provide information via news releases to mass media and special articles in conservation publications on time and place for crane viewing.

d. Develop outreach explaining facts regarding hunting to non-consumptive users.

Rationale: Sandhill cranes are spectacular birds which attract considerable interest among non-consumptive users. Unfortunately, MCP cranes spend much of their time in relatively remote areas of flat terrain. Publicity regarding where and when to observe cranes and observation aids at such locations does attract considerable use as evidenced by events during the spring migration in Nebraska.

Responsibilities: All cooperating agencies.

Table 2. Thresholds used to determine regulatory hunting season alternatives for the mid-continent population of sandhill cranes. The 3-year population index must cross a threshold for three consecutive years before bag limit reductions or increases are implemented.

Population Threshold (Number of Cranes)	Regulatory Alternative	Daily Bag Limit	Days
Above 350,000	Standard	3 or 2	Varies by zone/state
Between 350,000 - 275,000 (20% of lower threshold)	Moderate	Reduced by 1	Unchanged
Between 275,000 – 200,000 (40% of lower threshold)	Restrictive	Reduced by 2 or Closed	Unchanged
Below 200,000 (50% of lower threshold)	Closed	Closed	Closed

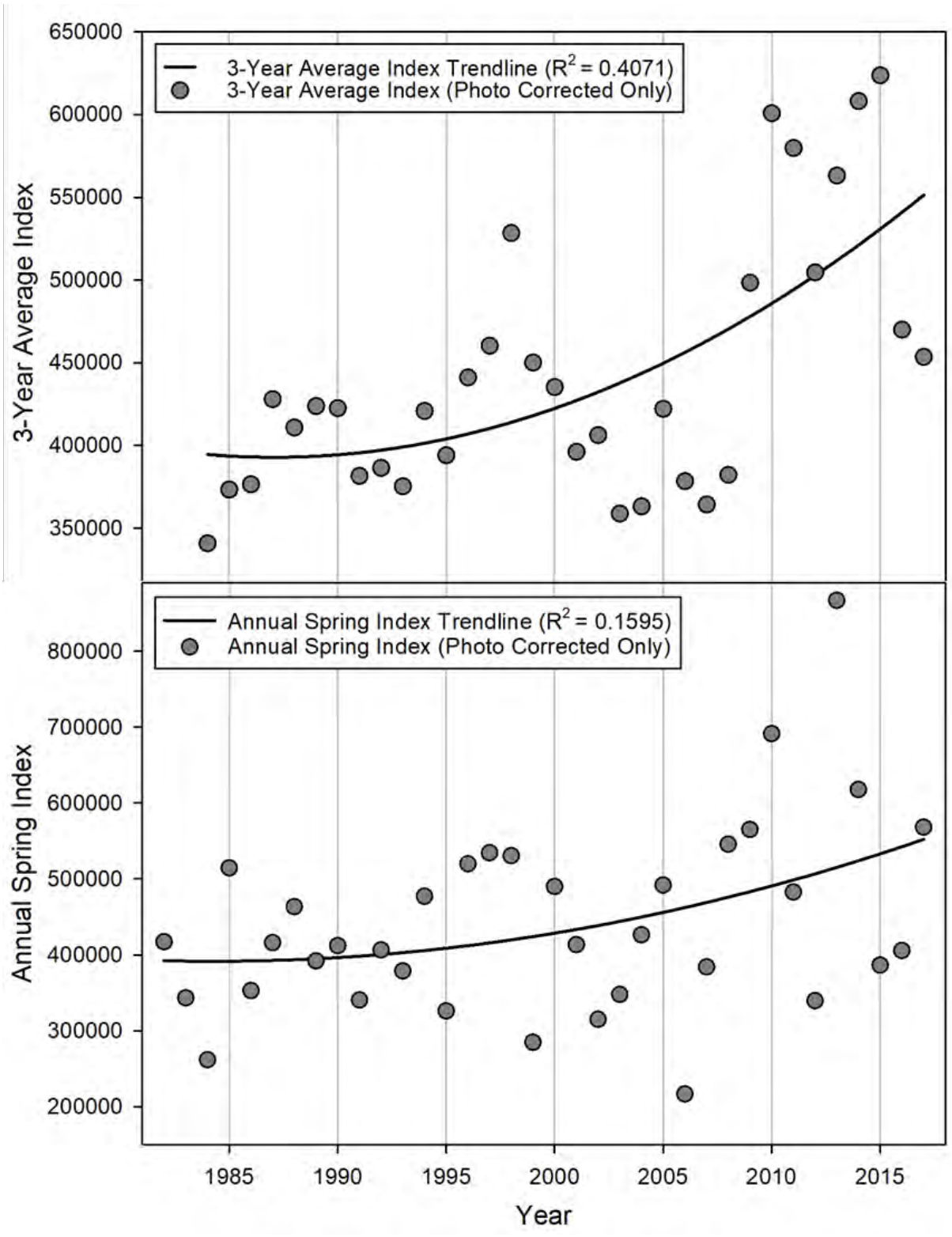

Figure 5. Quadratic regressions of annual and 3-year average abundance indices for the mid-continent population of sandhill cranes from 1982-2017. Abundance includes only photo-corrected ocular transect counts within the Platte River Valley of Nebraska.

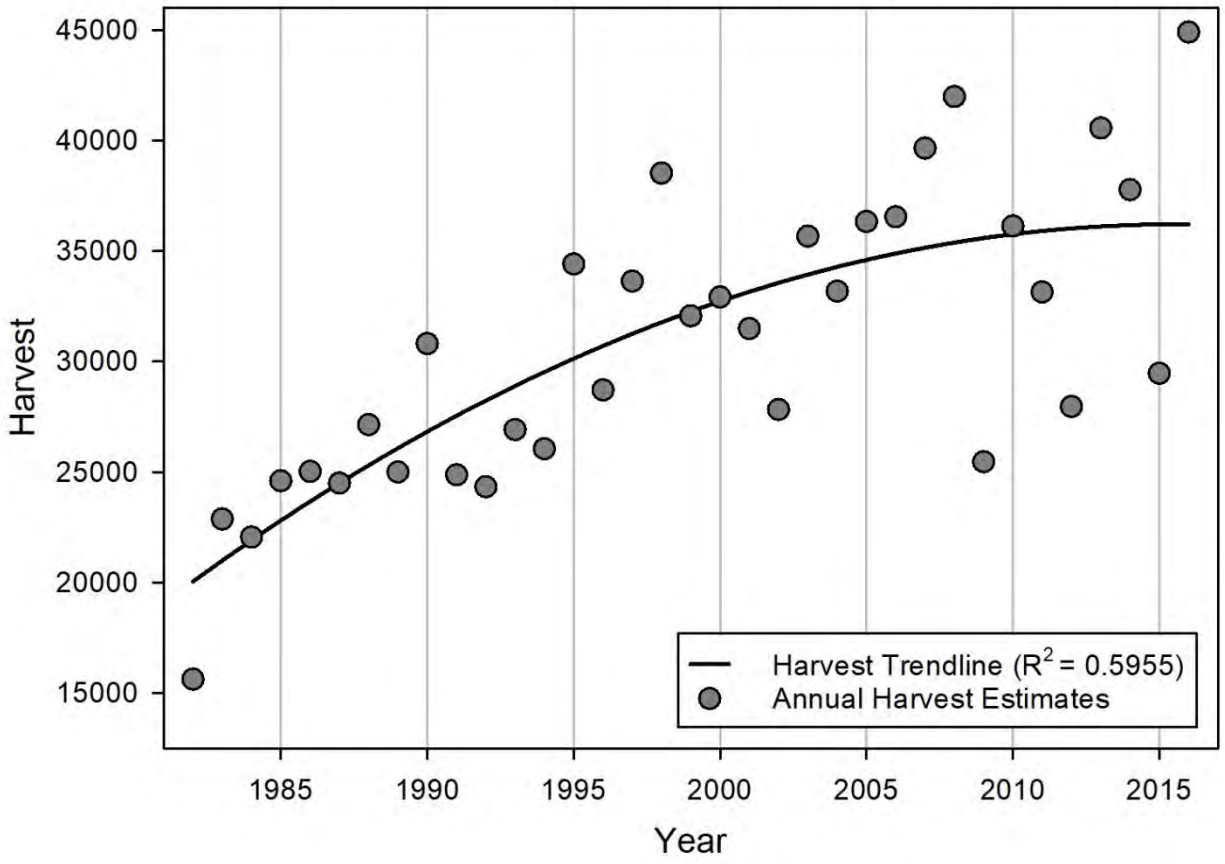

Figure 6. Quadratic regression of sport hunting mortality for the mid-continent population of sandhill cranes from 1982-2016. Harvest includes retrieved and unretrieved estimates from Central and Pacific Flyway states, Canada, and Mexico.

RESEARCH NEEDS

Researchers continue to add valuable knowledge to the management of mid-continent population sandhill cranes (MCP cranes). However, additional information is needed to refine population monitoring techniques and enhance management of MCP cranes. Cooperative funding agreements are imperative for meeting these future research needs. Information has been identified that will meet these needs and support ongoing management programs. The first primary research needs come from the Priority Information Needs for Sandhill Cranes II: Funding Strategy (Collins et al. 2016).

1. Assessing finer-scale management of the mid-Continent population. Continue to evaluate feasibility of managing harvest at a scale smaller than the MCP by determining whether spatial and temporal differences exist for distributions of breeding affiliations of MCP cranes in fall, and whether they are substantial enough to warrant differential management of the affiliations.

2. Improving Population Abundance Estimates for the mid-continent population.

Other research topics of interest are noted below in an unprioritized listing. These may also enhance management of mid-continent sandhill cranes.

1. Assess the feasibility of a banding program to estimate abundance, survival, and harvest rates of MCP sandhill cranes.

2. Evaluate different techniques to determine age ratios among harvested MCP cranes such as collection of wings, wing-tips, contour feathers, or skin from the forehead.

3. Continue to assess corn availability in the Platte River region while developing more efficient methods of data collection.

Responsibilities: All cooperating agencies and research groups.

MAINTENANCE OF GUIDELINES

These guidelines will be maintained by the appropriate technical committees of the Central, Mississippi, and Pacific Flyways. The parties to this plan will provide revisions to the 2018 plan when significant advances to the harvest strategy and/or monitoring methods are completed. Such changes will be recommended to the Councils for adoption.

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Appendix A

Table A1. Descriptions of breeding affiliations for mid-continent population sandhill cranes based on mitochondrial DNA and morphometry described by Krapu et al. 2011 and 2014. Greater sandhill cranes are considered large in size, Canadian sandhill cranes intermediate, and lesser sandhill cranes small. Weights and associated sample sizes for each type are listed below from Johnson and Stewart 1973.

	Greater sandhill crane *A. c. tabida*		**Canadian sandhill crane** *A. c. rowani*		**Lesser sandhill crane** *A. c. canadensis*	
	Males (11)	Females (10)	Males (51)	Females (33)	Males (31)	Females (17)
Mass (kg)	4.89 ± 0.37	4.45 ± 0.43	4.80 ± 0.39	4.11 ± 0.25	3.95 ± 0.30	3.46 ± 0.25

Affiliation: East-central Canada/Minnesota (EC-M)

Breeding Distribution: Hudson Bay Lowlands near James Bay in northeastern Manitoba, northern Ontario and western Quebec, the Interlake region of central Manitoba, and northwestern Minnesota and adjacent parts of southeastern Manitoba.

Mitochondrial DNA	93%	Greater sandhill crane
	3%	Lesser sandhill crane
	3%	Unclassified
Morphometry	70%	Canadian sandhill crane
	30%	Greater sandhill crane

Affiliation: West-central Canada-Alaska (WC-A)

Breeding Distribution: Central Saskatchewan, across central and northern Alberta, northeastern British Columbia, the Great Slave Plains in the Northwest Territories, and in the Yukon Flats of east-central Alaska.

Mitochondrial DNA	85%	Greater sandhill crane
	15%	Lesser sandhill crane
Morphometry	90%	Canadian sandhill crane
	8%	Greater sandhill crane
	2%	Lesser sandhill crane

Affiliation: Western Alaska-Siberia (WA-S)

Breeding Distribution: Western Alaska from the Yukon-Kuskokwim Delta northward to the Seward Peninsula and in northeastern Russia.

Mitochondrial DNA	92%	Lesser sandhill crane
	4%	Greater sandhill crane
	4%	Unclassified
Morphometry	88%	Lesser sandhill crane
	12%	Canadian sandhill crane

Affiliation: Northern Canada-Nunavut (NC-N)

Breeding Distribution: Near the Arctic Ocean in the Yukon Territory eastward to the Boothia Peninsula, in parts of the Canadian Archipelago (i.e., Richards Island, Banks Island, and Victoria Island), and on the northwest side of Hudson Bay.

Mitochondrial DNA	96%	Lesser sandhill crane
	4%	Unclassified
Morphometry	83%	Lesser sandhill crane
	17%	Canadian sandhill crane

Table A-2. Survey dates and coinciding weekdays for conducting the annual ocular transect survey in the Platte River Valley of Nebraska.

Year	Survey Dates, March 22-26 (coinciding weekdays)
2018	Thursday – Monday
2019	Friday – Tuesday
2020	Sunday – Thursday
2021	Monday – Friday
2022	Tuesday – Saturday
2023	Wednesday – Sunday
2024	Friday - Tuesday
2025	Saturday – Wednesday
2026	Sunday – Thursday
2027	Monday – Friday
2028	Wednesday – Sunday
2029	Thursday – Monday
2030	Friday - Tuesday
2031	Saturday – Wednesday
2032	Monday – Friday
2033	Tuesday – Saturday
2034	Wednesday – Sunday
2035	Thursday - Monday

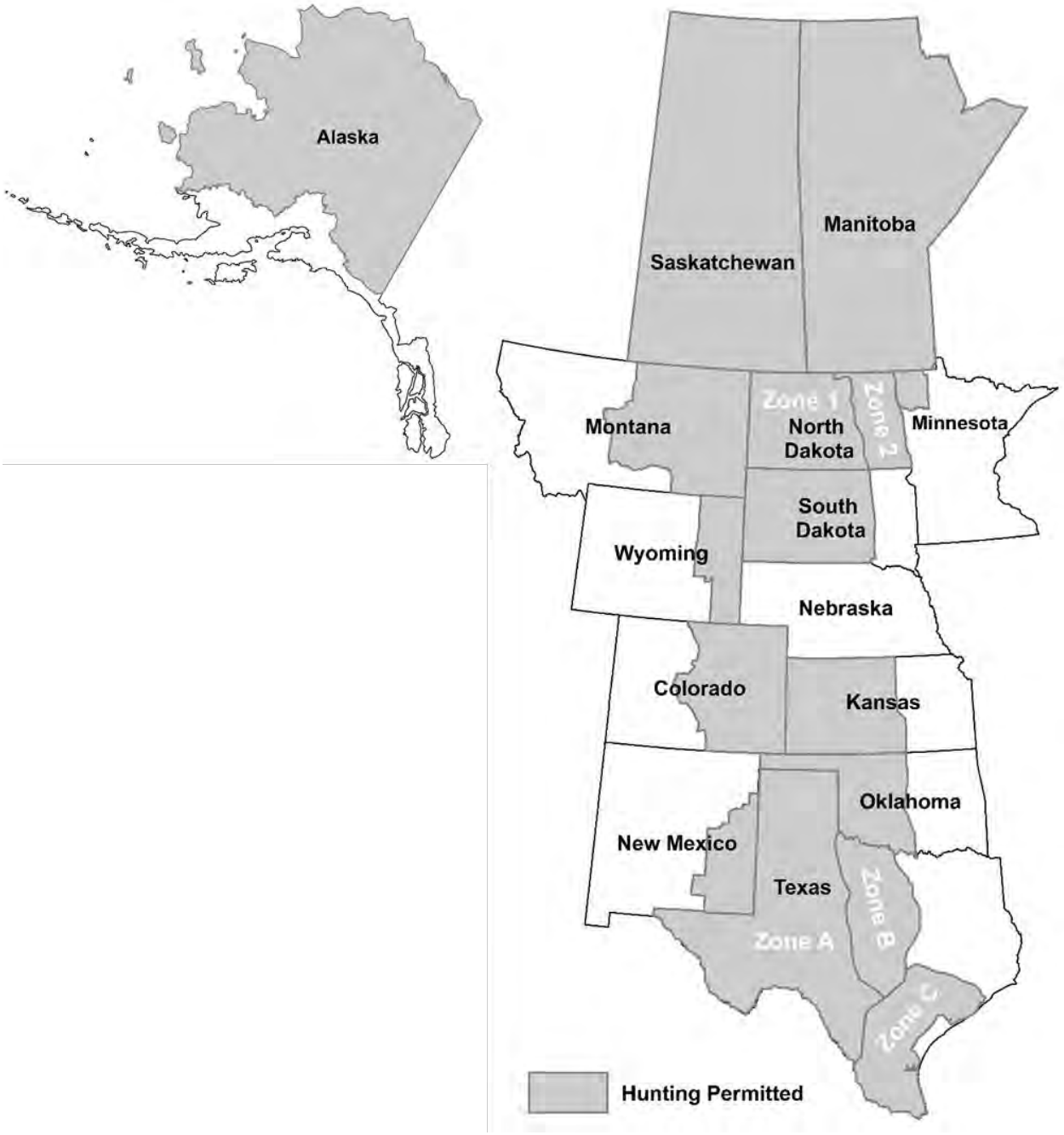

Figure A-1. Current boundaries for mid-continent sandhill crane hunting areas in United States and Canada as of the 2017-2018 hunting season. See Table A-3 for current frameworks associated with each area and zone.

Table A-3. Current frameworks by state/province in United States and Canada for mid-continent sandhill crane hunting as of the 2017-2018 hunting season.

	State	Zone	Outside Dates:	Days Allowed:	Daily Bag Limit:
Pacific Flyway[a]					
	Alaska		September 1 – January 26	107	3
Central Flyway					
	Saskatchewan[b]		September 1 – December 16	107	5
	North Dakota	1	September 1 – February 28	58	3
	North Dakota	2	September 1 – February 28	58	2
	Montana		September 1 – February 28	58	3
	South Dakota		September 1 – February 28	58	3
	Wyoming		September 1 – February 28	58	3
	Colorado		September 1 – February 28	58	3
	Kansas		September 1 – February 28	58	3
	Oklahoma		September 1 – February 28	93	3
	New Mexico		September 1 – February 28	93	3
	Texas	A	September 1 – February 28	93	3
	Texas	B	September 1 – February 28	93	3
	Texas	C	September 1 – February 28	37	2
Mississippi Flyway					
	Manitoba[b]		September 1 – November 30	91	5
	Minnesota		September 1 – February 28	37	2

[a] Some harvest of sandhill cranes occurs in southeastern Arizona as part limited season which allows the take of (3) sandhill cranes per calendar year from either the mid-continent or Rocky Mountain populations.

[b] Outside dates are not used in Canada, the current season dates are represented in this column for these provinces.

Table A-4. Estimated annual harvest reductions when lowering daily bag limits by 1 and 2 birds during hunting season for states that harvest mid-continent population sandhill cranes.

Area	Avg Harvest (2005-2015)	Country %	Total %	Bag Limit	Days	Bag Limit Reduction (-1)	Harvest Change	Bag Limit Reduction (-2)	Harvest Change
Alaska	774	4.2%	2.8%	2 or 3	107	-7.3%	-56	-36.4%	-281
Colorado	95	0.5%	0.3%	3	58	-9.4%	-9	-37.7%	-36
Kansas	620	3.3%	2.2%	3	58	-14.4%	-89	-46.5%	-288
Montana	63	0.3%	0.2%	3	58	-9.3%	-6	-34.0%	-21
Minnesota	473	2.5%	1.7%	1[a] or 2	37	-------	0	-------	0
New Mexico	430	2.3%	1.5%	3	93	-13.0%	-56	-44.7%	-192
North Dakota - Zone 1	3,500	18.8%	12.6%	3	58	-15.3%	-536	-46.6%	-1,630
North Dakota - Zone 2	267	1.4%	1.0%	2	37 or 58[b]	-27.6%	-74	-27.6%	-74
Oklahoma	589	3.2%	2.1%	3	93	-19.8%	-117	-52.5%	-309
South Dakota	127	0.7%	0.5%	3	58	-17.1%	-22	-44.4%	-56
Texas - Zone A	8,894	47.9%	32.0%	3	93	-14.8%	-1,316	-62.6%	-5,567
Texas - Zone B	511	2.8%	1.8%	3	58[c]	-15.5%	-79	-43.3%	-221
Texas - Zone C	2,206	11.9%	7.9%	2	37	-30.7%	-677	-30.7%	-677
Wyoming	25	0.1%	0.1%	3	58	-11.3%	-3	-39.8%	-10
United States Total	**18,574**	**1**	**66.7%**			**-16.4%**	**-3,039**	**-50.4%**	**-9,363**
Manitoba	1,778	19.2%	6.4%	5	91	*	*	*	*
Saskatchewan	7,475	80.8%	26.9%	5	107	*	*	*	*
Canada Total	**9,253**		**33.3%**						
TOTAL	**27,827**		**100.0%**						

[a] Current state imposed restrictions on daily bag limit = 1, so no decrease in harvest with further restrictions.

[b] Federal frameworks in season length increased in 2014 from 37 to 58 days.

[c] Current state imposed restriction on season length from 93 days to 58 or less days.

Appendix B

HISTORY OF MID-CONTINENT POPULATION OF SANDHILL CRANE HUNTING, REGULATIONS, AND HARVEST

Legal Status. Cranes (family Gruidae) are protected internationally under the migratory bird conventions between the United States and Canada (as amended in 1997) between the US and Mexico (as amended in 1997), and Russia (1976). Hunting of migratory birds in the United States is regulated by the Migratory Bird Treaty Act (MBTA, 40 Stat. 755; 16 U.S.C. 703) that gives effect to the international treaties. Migratory birds defined as "game birds" in the terms of these conventions and MBTA are listed in section 20.11 of Part 1, Title 50, Code of Federal Regulations and include the Family Gruidae.

The treaty with Canada in 1916 listed "Gruidae or cranes, including little brown, sandhill, and whooping cranes." Subsequently, the little brown crane and sandhill crane were shown to be subspecies of a single species (Oberholser 1921). Intermediates between the lesser and greater subspecies were then described morphologically. The "little brown crane" is now called the lesser sandhill crane; the "sandhill crane" is now called the greater sandhill crane. The “intermediate” formerly recognized as a separate subspecies (Walkinshaw 1965) is now considered only a hybrid based upon mtDNA analyses (Rhymer et al. 2001, Glenn et al. 2002, Peterson et al. 2003). We generally do not distinguish harvest of mid-continent population of sandhill cranes (MCP) by subspecies because the morphological differences are not readily identifiable and are becoming less distinguishable with time. Current discrimination is only attempted in those instances where ranges overlap with other populations dominated by one subspecies.

Hunting Regulations. A general closed season was established on all cranes in the United States, May 20, 1916. It remained in effect until January 1, 1961, when a 30-day season was authorized on lesser sandhill cranes in eastern New Mexico (NM) and western Texas (TX). TX did not participate at that time because cranes were not defined as game birds in statute. In the fall of 1961, a 30-day season was authorized for Alaska (AK; Sept. 1-30) and in NM and West TX (Nov. 4-Dec. 3). Minor changes were made in subsequent seasons in these states. The area open to hunting in NM and TX was enlarged, and the hunting period in AK was increased to 45 days during the 1964-65 waterfowl season. In 1977, migratory bird seasons in AK were standardized, and crane seasons were allowed for the full 107-day framework for waterfowl, recognizing that only 45 days of hunting actually are available before freeze-up.

In 1967, hunting was permitted in the Central Flyway (CF) portion of Colorado (CO), exclusive of the San Luis Valley and, in the following year, in western Oklahoma (OK), the eastern portion of the TX panhandle, and prescribed areas of North Dakota (ND) and South Dakota (SD). In 1972, hunting was permitted in prescribed areas of Montana (MT) and Wyoming (WY).

From 1968-1979 in ND, the number of counties open to hunting was expanded from 2 to 8 (Dubovsky 2017, Sharp and Cornely 1997). From 1980-92, the number of counties with open seasons increased to 30 and were grouped into two zones. In 1993, crane hunting opened statewide west of U.S. Hwy. 281 and used full federal frameworks.

In 1993, western Kansas (KS) was opened to hunting. In 2001, ND and TX accepted a reduction in season length and daily bag limit to slightly expand the area open to hunting. Except for these changes in the last 10 years, the area open to hunting has remained relatively unchanged. However, ND added 21 days

to the eastern zone (Unit 2) in 2013. Nebraska is the only CF state that currently does not have a recreational hunting season.

MCP cranes have been legally hunted in Mexico since at least 1940, and in portions of Canada since 1959. In 2016, only Manitoba (MB), Saskatchewan (SK) and Yukon Territory (YT) had open seasons for sandhill cranes. Hunting season dates, 1961- 2017, in Central Flyway states, AK, MB, and SK are listed in Tables C-l and C-2.

In 1997, the United States Senate ratified amendments to the migratory bird treaties with Canada and Mexico to legally recognize and regulate traditional spring and summer hunting in AK and Canada. The Alaska Migratory Bird Co-management Council (AMBCC) was established to broadly involve subsistence hunters in migratory bird management, as well as establish the first spring and summer hunting regulations. In 2003, the first legal spring and summer season commenced under federal regulations. The AMBCC annually reviews proposed regulatory changes, consults with the Flyway Councils, and makes recommendations to the USFWS.

Harvest. NM obtained estimates of its crane harvest via hunter questionnaire beginning with the first season in January 1961. ND and OK also estimated harvest from hunter questionnaires through the mid-1970s. Harvest was minimal in ND until hunting in September was authorized in 1977. TX, an important crane harvest state, relied upon periodic harvest estimates made by field personnel; these estimates ranged from 890 (1966) to 3,076 (1971).

Surveys in SK and MB indicated hunters took ca. 2,959 cranes/year 1972-76. However, these estimates did not include unretrieved or subsistence harvest. Harvest has been quite variable in Canada since 1971, but has increased substantially starting in the late 1990's (Table C-6).

The annual harvest in Mexico was estimated to be 500-1,000 cranes through the mid-1970s (Baer *in* Lewis 1977:28). Because there are no comprehensive harvest surveys in Mexico and interest in crane hunting is believed to be increasing in Mexico, commensurate with that in the United States, it has been assumed that harvest has been proportional (10%) to the combined United States and Canadian sandhill crane harvests (R. Drewien, personal communication). This assumed low harvest level has been supported by an independent assessment of harvest in Mexico (Kramer et al. 1995).

Since 1975, federal sandhill crane hunting permits have been required for all hunters participating in seasons in the U.S. portion of the CF (Table C-3, Dubovsky 2017). The permits were supplied to the states by the USFWS and initially were issued free of charge to hunters upon request. The USFWS mails a questionnaire to a sample of these permit holders at the close of the hunting season. Responses are expanded to estimate hunting activity and success in each geographic area or state (Martin 2005). The questionnaire includes inquiries about number of days hunted, retrieved and unretrieved harvest, and counties hunted. Follow-up questionnaires have been mailed to non-respondents to improve response rates.

The harvest survey indicates that the number of active hunters has increased in the CF since the early 2000's, but has been highly variable (Table C-4). TX and ND hunters comprise the majority of active hunters in the Central Flyway (Table C-4). Hunter participation and harvest in MT, WY, CO, SD, NM and KS has been relatively small. Past studies indicate that only about half of permit holders actually harvest a crane during the hunting season (Martin 2005). Approximately 40% take 1 - 3 and the remaining 10% take more than 3 per hunting season (Martin 2005). Hunter reported unretrieved harvest in the United States portion of the CF has remained relatively stable since the late 1990's (Dubovsky 2017).

However, the estimated total hunting mortality for the MCP has leveled off, but become more variable since 2000 (Figure 6). Largest increases in harvest were seen in the Central Flyway during the 1990s, but have since decreased. Since the late 1990's large increases in harvest have been seen in SK (Tables C-6 and C-7). Estimated seasonal bag per hunter in the Central Flyway has ranged from about 1.5 in the 1970s to about 2.5 in the 1990s; however, in recent years, seasonal bag per hunter has again decreased to < 2.

Recent Harvest surveys indicated that a 16.5% reduction in harvest would be realized with a bag limit change from 3 to 2, and a 48.9% reduction in harvest with a bag limit change from 2 to 1 (Table A-4). However, a more thorough analysis including effects of incremental reduction in season lengths and changes in opening dates could be completed.

Subsistence harvest of MCP historically was poorly documented in the United States and Canada (Dubovsky 2017). In the 1980s, the state of Alaska initiated a broad program of subsistence harvest surveys of 151 rural communities (Wolfe et al. 1990). About the same time, an intensive village harvest survey program was designed and implemented to measure subsistence harvest of geese, other waterfowl, cranes, and other birds on the Yukon-Kuskokwim Delta (YKD). On the YKD, where the highest densities of MCP cranes in AK occur, subsistence harvest averaged 3,240 cranes and 500 eggs from 1985-1995 (Wentworth and Seim 1996). During the period 1996-2002, average harvest for the region was 3,111 cranes and 500 eggs (Wentworth, unpublished data). Harvest surveys from other parts of AK that host MCP cranes are not complete, but Wolfe et al. (1990) characterized crane harvest from these other regions at about 3,000 birds, the most notable area being the Seward Peninsula where cranes are traditionally hunted during migration to and from Siberia. Since 2003, a statewide subsistence harvest survey program has been implemented through the AMBCC; this effort has provided a more systematic approach to obtain harvest information for all subsistence hunting areas across AK. During the period 2004-2014, average annual harvest was 3,270 cranes on the YKD, 1,525 cranes on the Seward Peninsula, and 91 cranes in other regions where MCP cranes occur.

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Appendix C

Table C-1. Season dates (month/day) for sandhill crane hunting in Central Flyway states and Minnesota, 1960-present (Dubovsky 2017).

YR	CO	KS	MT[1]	MT[2]	NM	ND[1]	ND[2]	OK	SD	TX[1]	TX[2]	TX[3]	WY	MN
1960	-	-	-	-	01/01-01/30	-	-	-	-	-	-	-	-	-
1961	-	-	-	-	11/04-12/03	-	-	-	-	11/04-12/03	-	-	-	-
1962	-	-	-	-	11/03-12/02	-	-	-	-	11/03-12/02	-	-	-	-
1963	-	-	-	-	11/02-12/01	-	-	-	-	11/02-12/01	-	-	-	-
1964	-	-	-	-	10/31-11/29	-	-	-	-	10/31-11/29	-	-	-	-
1965	-	-	-	-	10/30-11/28	-	-	-	-	10/30-11/28	-	-	-	-
1966	-	-	-	-	10/29-11/27	-	-	-	-	10/29-11/27	-	-	-	-
1967	10/01-10/30	-	-	-	11/04-01/02	-	-	-	-	11/04-01/02	-	-	-	-
1968	10/01-10/30	-	-	-	11/02-12/28	11/09-12/08	-	12/14-01/02	11/09-12/08	11/02-12/28	12/14-01/02	-	-	-
1969	10/04-11/02	-	-	-	11/01-12/28	11/08-12/07	-	12/13-01/11	11/08-12/07	11/01-12/28	12/13-01/11	-	-	-
1970	10/03-11/01	-	-	-	10/31-01/10	11/14-12/13	-	12/05-01/10	11/14-12/13	10/31-01/10	12/05-01/10	-	-	-
1971	10/02-11/07	-	-	-	10/30-01/30	11/13-12/02	-	12/04-01/30	11/13-12/02	10/30-01/30	12/04-01/30	-	-	-
1972	10/01-11/05	-	10/01-11/06	-	11/03-01/31	11/11-12/10	-	12/02-01/28	11/11-12/10	10/28-01/28	12/02-01/28	-	10/07-11/05	-
1973	10/01-11/05	-	09/29-11/04	-	10/27-01/27	11/10-12/09	-	12/01-01/27	11/10-12/09	10/27-01/27	12/01-01/27	-	10/13-11/11	-
1974	10/01-11/05	-	09/28-11/03	-	10/26-01/26	11/09-12/08	-	11/30-01/26	11/09-12/08	10/26-01/26	11/30-01/26	-	10/12-11/10	-
1975	10/04-11/08	-	10/04-11/09	-	10/25-01/25	11/08-12/07	-	11/29-01/25	11/08-12/07	10/25-01/25	11/29-01/25	-	10/11-11/09	-
1976	10/02-11/06	-	10/02-11/07	-	10/30-01/30	11/06-12/05	-	11/27-01/23	11/06-12/05	10/30-01/30	12/04-01/30	-	10/09-11/07	-
1977	10/01-11/06	-	10/01-11/06	-	10/29-01/29	09/07-09/11	-	11/26-01/22	09/07-09/11	11/01-01/31	12/05-01/31	-	10/08-11/06	-
1978	09/30-11/05	-	09/30-11/05	-	10/28-01/28	09/07-09/11	-	11/25-01/21	09/07-09/11	10/31-01/31	12/05-01/31	-	10/07-11/05	-
1979	10/13-11/18	-	09/29-11/04	-	10/27-01/27	09/07-09/11	-	11/24-01/20	09/07-09/11	10/30-01/30	12/04-01/30	-	10/13-11/18	-
1980	10/11-11/16	-	10/04-11/09	-	10/30-01/31	09/06-09/14	09/06-09/10	11/22-01/18	09/20-09/28	10/31-01/31	12/05-01/31	-	10/11-11/16	-
1981	10/10-11/15	-	10/03-11/08	-	10/31-01/31	09/05-09/20	09/05-09/13	11/22-01/18	09/20-09/28	10/31-01/31	12/05-01/31	-	10/03-11/08	-
1982	10/02-11/28	-	10/02-11/28	-	10/31-01/31	09/04-09/19	09/04-09/12	10/23-01/23	10/02-11/11	10/30-01/30	12/04-01/30	-	09/25-11/21	-
1983	10/01-11/27	-	11/01-11/27	11/01-11/27	10/29-01/28	09/10-11/06	09/10-09/30	10/22-01/22	10/01-11/06	11/12-02/12	12/03-02/12	01/14-02/12	09/24-11/20	-
1984	09/29-11/25	-	09/29-11/25	11/01-11/25	10/27-01/27	09/08-11/04	09/08-09/28	10/13-01/13	09/29-11/04	11/10-02/10	12/01-02/10	01/12-02/10	09/22-11/18	-
1985	09/28-11/24	-	09/28-11/24	11/01-11/24	10/26-01/26	09/07-11/03	09/07-09/27	10/12-01/12	09/28-11/03	11/09-02/09	11/30-02/09	01/11-02/09	09/21-11/17	-
1986	10/04-11/30	-	10/04-11/30	11/01-11/30	10/25-01/25	09/06-11/02	09/06-10/03	10/11-01/11	09/28-11/02	11/08-02/08	11/29-02/08	01/03-02/08	09/20-11/16	-
1987	10/03-11/29	-	10/03-11/29	10/03-11/29	10/24-01/24	09/05-11/01	09/05-10/02	10/10-01/17	09/26-11/01	11/14-02/14	11/28-02/07	01/02-02/07	09/19-11/15	-
1988	10/01-11/27	-	10/01-11/27	10/01-11/27	10/22-01/22	09/10-11/06	09/10-09/30	10/22-01/22	09/24-10/30	11/12-02/12	11/26-02/05	01/07-02/12	09/17-11/13	-
1989	09/30-11/26	-	09/30-11/26	09/30-11/26	10/21-01/21	09/09-11/05	09/09-09/29	10/21-01/21	09/30-11/05	11/11-02/11	12/02-02/11	01/06-02/11	09/16-11/12	-
1990	09/29-11/25	-	09/29-11/25	09/29-11/25	10/20-01/20	09/08-11/04	09/08-10/14	10/20-01/20	09/29-11/04	11/10-02/10	12/01-02/10	01/05-02/10	09/15-11/11	-
1991	09/28-11/24	-	09/28-11/24	09/28-11/24	10/19-01/19	09/07-11/03	09/07-10/13	10/19-01/19	09/28-11/03	11/09-02/09	12/07-02/09	01/04-02/09	09/15-11/11	-
1992	10/03-11/29	-	09/26-11/22	09/26-11/22	10/17-01/17	09/05-11/01	09/05-10/11	10/17-01/17	09/26-11/01	11/14-02/14	12/05-02/14	01/02-02/07	09/15-11/11	-
1993	10/02-11/28	11/06-01/02	09/25-11/21	09/25-11/21	10/16-01/16	09/11-11/07	09/11-11/07	10/16-01/16	09/25-10/31	11/13-02/13	12/04-02/13	01/08-02/13	09/15-11/11	-
1994	10/01-11/27	11/05-01/05	09/24-11/20	09/24-11/20	10/15-01/15	09/10-11/06	09/10-11/06	10/15-01/15	09/24-10/30	11/12-02/12	12/03-02/12	01/07-02/12	09/15-11/11	-
1995	09/30-11/26	11/05-01/05	09/23-11/19	09/23-11/19	10/31-01/31	09/09-11/05	09/09-11/05	10/22-01/28	09/23-11/19	11/11-02/11	12/02-02/11	01/06-02/11	09/14-11/10	-
1996	10/05-12/01	11/02-12/29	09/28-11/24	09/28-11/24	10/31-01/31	09/07-11/03	09/07-11/03	10/26-01/26	09/28-11/24	11/09-02/09	11/30-02/09	01/04-02/09	09/14-11/10	-
1997	10/04-11/30	11/01-12/28	10/04-11/30	10/04-11/30	10/31-01/31	09/06-11/02	09/06-11/02	10/25-01/25	09/27-11/23	11/08-02/08	11/29-02/08	01/03-02/08	09/13-11/09	-
1998	10/03-11/29	11/07-01/03	10/03-11/29	09/12-09/20	10/31-01/31	09/05-11/01	09/05-11/01	10/24-01/24	09/26-11/22	11/07-02/07	11/28-02/07	01/02-02/07	09/12-11/08	-
1999	10/02-11/28	11/06-01/02	10/02-11/28	09/11-09/19	10/30-01/30	09/11-11/07	09/11-11/07	10/30-01/30	09/25-11/21	11/13-02/13	12/04-02/13	01/08-02/13	09/11-11/07	-
2000	10/07-12/03	11/04-12/31	09/30-11/26	09/09-09/17	10/31-01/31	09/16-11/12	09/16-11/12	11/04-02/04	09/23-11/19	11/11-02/11	12/02-02/11	12/30-02/04	09/09-11/05	-
2001	10/07-12/03	11/03-12/30	09/29-11/25	09/08-09/16	10/31-01/31	09/15-11/11	09/15-10/21	11/03-02/03	09/22-11/18	11/10-02/10	12/01-02/10	12/29-01/20	09/15-11/11	-
2002	10/05-12/01	11/02-12/29	09/28-11/24	09/07-09/15	10/31-01/31	09/21-11/17	09/21-10/27	11/09-02/09	09/21-11/17	11/09-02/09	11/30-02/09	12/21-01/19	09/14-11/10	-
2003	10/04-11/30	11/01-12/28	09/27-11/23	09/06-09/14	10/31-01/31	09/20-11/16	09/20-10/26	10/25-01/25	09/27-11/23	11/01-02/01	11/22-02/01	12/20-01/18	09/13-11/09	-
2004	10/02-11/28	11/06-1/02	09/25-11/21	09/11-09/19	10/31-01/31	09/18-11/14	09/18-10/24	10/30-01/30	09/25-11/21	11/06-02/01	11/27-02/01	12/18-01/16	09/18-11/14	-
2005	10/01-11/27	11/09-01/05	09/24-11/20	09/10-09/18	10/31-01/31	09/17-11/13	09/17-10/23	10/29-01/29	09/24-11/20	11/05-02/05	11/26-02/05	12/24-01/29	09/17-11/13	-
2006	09/30-11/26	11/08-01/04	09/23-11/19	09/09-09/17	10/31-01/31	09/16-11/12	09/16-10/22	10/28-01/28	09/23-11/19	11/04-02/04	11/24-02/04	12/23-01/28	09/16-11/12	-
2007	10/02-12/02	11/07-01/03	09/22-11/28	09/08-09/16	10/31-01/31	09/15-11/11	09/15-10/21	10/27-01/27	09/22-11/18	11/04-02/04	11/24-02/04	12/23-01/28	09/15-11/11	-
2008	10/04-11/30	11/05-01/01	09/27-11/23	09/06-09/21	10/31-01/31	09/20-11/16	09/20-10/26	10/25-01/25	09/27-11/23	11/08-02/08	11/28-02/08	12/20-01/25	09/13-11/09	-
2009	10/03-11/29	11/11-01/07	09/26-11/22	09/05-09/20	10/31-01/31	09/19-11/15	09/19-10/25	10/24-01/24	09/26-11/22	11/07-02/07	11/27-02/07	12/19-01/24	09/19-11/15	-
2010	10/02-11/28	11/10-01/06	09/25-11/21	09/11-09/26	10/31-01/31	09/18-11/14	09/18-10/24	10/23-01/23	09/25-11/21	11/06-02/06	11/26-02/06	12/18-01/23	09/18-11/14	09/04-10/10
2011	10/01-11/27	11/09-01/05	09/24-11/20	09/10-09/25	10/31-01/31	09/17-11/13	09/17-10/23	10/22-01/22	09/24-11/20	11/05-02/05	11/25-02/05	12/24-01/29	09/17-11/13	09/03-10/09
2012	09/29-11/25	11/07-01/03	09/29-11/25	09/8-09/30	10/31-01/31	09/15-11/11	09/15-10/21	10/20-01/20	09/22-11/18	11/03-02/03	11/23-02/03	12/22-01/27	09/15-11/11	09/15-10/21
2013	10/05-12/01	11/06-01/02	09/2/-11/24	09/07-09/29	10/31-01/31	09/14-11/10	09/14-11/10	10/19-01/19	09/28-11/24	11/02-02/02	11/22-02/02	12/21-01/26	09/14-11/10	09/14-10/20
2014	10/04-11/30	11/05-01/01	10/04-11/30	09/13-10/05	10/31-01/31	09/14-11/10	09/14-11/10	10/18-01/18	09/27-11/23	11/01-02/01	11/21-02/01	12/20-01/25	09/13-11/09	09/13-10/19
2015	10/03-11/29	11/11-01/07	10/03-11/29	09/12-10/04	10/31-01/31	09/19-11/15	09/19-11/15	10/24-01/24	09/26-11/22	10/31-01/31	11/20-01/31	12/19-01/24	09/19-11/15	09/12-10/18
2016	10/01-11/27	11/09-01/05	10/01-11/27	09/10-10/02	10/29-01/29	09/17-11/13	09/17-11/13	10/22-01/22	09/24-11/20	10/29-01/29	11/18-01/29	12/17-01/22	09/17-11/13	09/10-10/16

MT[1] Central Flyway portion of MT, except that area south of I-90 and west of the Bighorn River and Sheridan Co.

MT[2] Sheridan County, MT.

ND[1] Area 1, ND.

ND[2] Area 2, ND.

TX[1] Area A, TX.

TX[2] Area B, TX.

TX[3] Area C, TX.

Table C-2. Regular season dates (mo/day) for mid-continent population sandhill crane hunting seasons in Alaska, Manitoba, and Saskatchewan, 1961 to 2017.

	State/Province				
Season	Alaska	Manitoba	Saskatchewan		
1961	09/01-09/30	-	-		-
1962	09/01-09/30	-	-		-
1963	09/01-09/30	-	-		-
1964	09/01-10/15	09/01-09/19	09/01-09/19		-
1965	09/01-10/15	09/01-09/18	09/01-09/18		-
1966	09/01-10/15	09/01-09/17	09/01-09/17		-
1967	09/01-10/15	09/01-09/16	09/01-09/16		-
1968	09/01-10/15	09/02-09/16	09/02-09/16		-
1969	09/01-10/15	09/01-09/13	09/01-09/13		-
1970	09/01-10/15	09/01-09/14	09/01-09/12		-
1971	09/01-10/15	09/01-09/14	09/01-09/11		-
1972	09/01-10/15	09/01-09/14	09/01-09/09		-
1973	09/01-10/15	09/02-09/14	09/02-09/07		-
1974	09/01-10/15	09/01-09/15	09/01-09/08		-
1975	09/01-10/15	09/01-09/13	09/01-09/06		-
1976	09/01-10/15	09/01-09/11	09/01-09/07		-
1977	09/01-12/16	09/01-09/10	09/01-09/07		-
1978	09/01-12/16	09/01-09/30	09/01-09/09		-
1979	09/01-12/16	09/01-09/30	09/01-09/08	&	09/17-09/22
1980	09/01-12/16	09/01-09/30	09/01-09/06	&	09/15-09/20
1981	09/01-12/16	09/01-09/30	09/01-09/05	&	09/14-09/19
1982	09/01-12/16	09/01-10/02	09/01-09/04	&	09/13-09/18
1983	09/01-12/16	09/01-10/01	09/01-09/06	&	09/14-09/20
1984	09/01-12/16	09/01-09/29	09/01-09/11	&	09/12-09/18
1985	09/01-12/16	09/01-09/28	09/02-09/17	&	09/11-09/24
1986	09/01-12/16	09/01-09/27	09/01-09/16	&	09/10-09/23
1987	09/01-12/16	09/01-09/26	09/01-09/15	&	09/09-09/22
1988	09/01-12/16	09/01-09/30	09/01-09/13	&	09/12-09/20
1989	09/01-12/16	09/01-09/30	09/01-09/12	&	09/11-09/19
1990	09/01-12/16	09/01-09/29	09/01-09/18	&	09/10-09/25
1991	09/01-12/16	09/02-09/28	09/02-09/17	&	09/09-09/24
1992	09/01-12/16	09/01-10/03	09/01-09/15	&	09/14-09/22
1993	09/01-12/16	09/01-10/02	09/01-09/14	&	09/01-09/29
1994	09/01-12/16	-	09/01-09/15	&	09/01-09/30
1995	09/01-12/16	09/01-09/30	09/01-09/30	&	09/01-09/30*
1996	09/01-12/16	09/01-09/28	09/02-09/30	&	09/02-09/30*
1997	09/01-12/16	09/01-09/27	09/01-09/30		-
1998	09/01-12/16	09/01-10/03	09/01-12/12		-
1999	09/01-12/16	-	09/01-12/11		-
2000	09/01-12/16	-	09/01-12/16		-
2001	09/01-12/16	09/01-11/30	09/01-12/16		-
2002	09/01-12/16	09/01-11/30	09/01-12/16		-
2003	09/01-12/16	09/01-11/30	09/01-12/16		-
2004	09/01-12/16	09/01-11/30	09/01-12/16		-
2005	09/01-12/16	09/01-11/30	09/01-12/16		-
2006	09/01-12/16	09/01-11/30	09/01-12/16		-
2007	09/01-12/16	09/01-11/30	09/01-12/16		-
2008	09/01-12/16	09/01-11/30	09/01-12/16		-
2009	09/01-12/16	09/01-11/30	09/01-12/16		-
2010	09/01-12/16	09/01-11/30	09/01-12/16		-
2011	09/01-12/16	09/01-11/30	09/01-12/16		-
2012	09/01-12/16	09/01-11/30	09/01-12/16		-
2013	09/01-12/16	09/01-11/30	09/01-12/16		-
2014	09/01-12/16	09/01-11/30	09/01-12/16		-
2015	09/01-12/16	09/01-11/30	09/01-12/16		-
2016	09/01-12/16	09/01-11/30	09/01-12/16		-
2017	09/01-12/16	09/01-11/30	09/01-12/16		-

* 1995 SASK ZN 21-23,29,30,41,44 (09/01-09/15)

* 1996 SASK ZN 21-23,29,30,41,44 (09/02-09/14)

Table C-3. Federal mid-continent sandhill crane permits issued in the U.S. portion of the Central Flyway and Minnesota (Dubovsky 2017).

YR	CO	KS	MT	NM	ND	OK	SD	TX	WY	CF TOTAL	MN
1975	401	-	158	1,225	4,172	171	198	5,482	56	11,863	-
1976	341	-	117	1,195	4,137	265	200	5,060	37	11,352	-
1977	374	-	82	1,452	6,294	519	134	4,897	48	13,800	-
1978	343	-	209	956	5,798	620	98	5,198	52	13,274	-
1979	528	-	159	1,288	4,949	470	63	5,098	43	12,598	-
1980	437	-	118	1,082	5,754	510	240	5,239	33	13,413	-
1981	397	-	53	1,022	5,796	466	197	5,297	30	13,258	-
1982	528	-	147	962	4,714	750	579	4,650	40	12,370	-
1983	575	-	175	706	8,033	909	528	7,317	63	18,306	-
1984	538	-	113	721	7,436	1,187	544	6,838	43	17,420	-
1985	555	-	143	710	6,802	1,102	656	7,417	59	17,444	-
1986	617	-	99	595	8,926	1,073	705	7,258	25	19,298	-
1987	610	-	128	502	8,778	1,213	517	6,289	30	18,067	-
1988	512	-	162	480	6,214	1,472	437	7,053	38	16,368	-
1989	434	-	172	430	6,128	1,717	524	8,066	25	17,496	-
1990	389	-	143	533	7,268	1,725	646	11,994	22	22,720	-
1991	501	-	238	602	3,353	1,618	668	11,142	25	18,147	-
1992	498	-	303	582	3,760	1,397	721	9,848	18	17,127	-
1993	411	575	336	541	4,572	1,277	708	10,407	37	18,864	-
1994	427	567	320	547	4,790	1,561	636	10,515	49	19,412	-
1995	571	711	351	564	5,242	1,323	650	10,755	42	20,209	-
1996	612	837	369	499	5,570	1,391	677	11,334	41	21,330	-
1997	572	997	325	454	4,934	1,393	757	37,365 [2]	46	46,843	-
1998	4,937 [2]	1,088	270	449	6,082	1,385	951	32,523 [2]	49	47,734	-
1999	4,847 [2]	1,235	279	516	6,050	1,438	810	33,380 [2]	52	48,607	-
2000	5,169 [2]	1,084	283	493	7,451	1,333	721	44,719 [2]	58	61,311	-
2001	5,869 [2]	1,374	253	509	8,078	1,315	680	49,410 [2]	72	67,560	-
2002	5,644 [2]	1,279	303	496	8,245 [2]	1,186	619	37,558 [2]	54	55,384	-
2003	5,854 [2]	1,206	273	471	6,030 [2]	1,000	563	43,199 [2]	50	58,646	-
2004	5,784 [2]	1,180	308	548	5,788 [2]	780	307	52,161 [2]	61	66,917	-
2005	5,766 [2]	805	281	494	7,441	698	490	51,511 [2]	68	67,554	-
2006	4,792 [2]	826	265	512	7,410	615	445	70,968 [2]	78	85,911	-
2007	4,931 [2]	598	238	480	7,442	731	390	101,382 [2]	58	116,250	-
2008	5,772 [2]	655	272	677	6,501	736	398	122,553 [2]	73	137,637	-
2009	4,038 [2]	540	139	862	7,774	1,029	693	11,332	62	26,469	-
2010	4,280 [2]	508	283	701	8,375	1,055	410	12,560	86	28,258	1,954
2011	783 [2]	801	311	575	8,024	1,104	356	13,905	86	25,945	1,342
2012	801 [2]	571	186	859	8,519	451	343	14,083	102	25,915	1,032
2013	856 [2]	735	288	404	9,085	2,278	421	18,369	106	32,542	1,086
2014	848 [2]	787	356	368	4,692	660	390	20,105	433	28,639	1,216
2015	787 [2]	1,040	404	365	4,543	510	-	22,033	454	30,136	1,199
2016 [1]	841 [2]	1,055	376	416	3,956	559	171	23,962	569	31,905	1,139
AVERAGES:											
1975-79	397	-	145	1,223	5,070	409	139	5,147	47	12,577	-
1980-89	520	-	131	721	6,858	1,040	493	6,542	39	16,344	-
1990-99	1,377	859	293	529	5,162	1,451	722	17,926	38	28,099	-
2000-09	5,362	955	262	554	7,216	942	531	58,479	63	74,364	-
2010-16	1,314	785	315	527	6,742	945	349	17,860	262	29,049	1,281
1975-16	1,995	877	233	663	6,307	1,024	494	23,339	83	34,626	-

[1]Preliminary

[2]Harvest Information Program (HIP) or a point of sale electronic record used to identify hunters in lieu of sandhill crane hunting permit.

Table C-4. Estimated active[1] mid-continent sandhill crane hunters in the Central Flyway and Minnesota (Dubovsky 2017).

YR	CO	KS	MT	NM	ND	OK	SD	TX	WY	TOTAL	MN
1975	226	-	69	806	2,896	80	117	2,733	22	6,949	-
1976	203	-	68	752	1,328	148	80	2,497	16	5,092	-
1977	189	-	40	921	4,126	339	77	2,329	27	8,048	-
1978	190	-	86	836	3,776	334	50	2,390	21	7,683	-
1979	275	-	61	745	3,225	307	29	2,356	13	7,011	-
1980	216	-	50	625	3,387	275	160	2,439	12	7,164	-
1981	216	-	23	598	3,315	269	103	2,543	14	7,081	-
1982	138	-	56	386	2,429	342	260	1,553	8	5,172	-
1983	211	-	64	253	3,551	384	225	2,435	20	7,143	-
1984	206	-	51	301	3,189	467	208	2,380	19	6,821	-
1985	187	-	37	216	2,383	372	168	2,613	12	5,988	-
1986	106	-	17	178	3,095	299	149	1,991	5	5,840	-
1987	113	-	29	133	2,529	358	120	1,942	5	5,229	-
1988	117	-	48	171	1,779	531	78	2,497	11	5,232	-
1989	74	-	52	152	2,018	492	153	2,805	6	5,752	-
1990	101	-	33	180	2,614	395	172	4,130	6	7,631	-
1991	153	-	69	220	1,674	370	139	3,231	3	5,859	-
1992	96	-	95	182	1,776	330	153	2,655	7	5,294	-
1993	87	294	97	218	2,223	357	140	3,602	5	7,023	-
1994	93	293	79	211	2,497	456	151	3,350	11	7,141	-
1995	154	393	118	211	2,408	331	143	3,707	6	7,471	-
1996	91	382	82	166	2,744	355	169	3,356	9	7,354	-
1997	67	452	68	124	2,386	264	178	4,515	10	8,064	-
1998	96	480	43	155	2,785	345	237	4,022	10	8,173	-
1999	133	533	60	204	2,444	375	173	2,699	8	6,629	-
2000	192	430	64	160	2,481	223	209	3,180	11	6,950	-
2001	202	555	72	173	2,934	391	145	3,554	13	8,039	-
2002	175	517	85	166	2,407	237	144	4,037	15	7,783	-
2003	236	495	60	244	2,271	64	114	4,821	10	8,315	-
2004	315	539	93	252	2,491	265	79	5,121	16	9,171	-
2005	280	274	90	233	3,370	259	165	5,383	24	10,078	-
2006	144	445	71	245	3,272	243	144	5,531	25	10,120	-
2007	158	255	82	241	3,145	166	57	5,685	19	9,808	-
2008	191	283	84	239	2,815	255	64	6,338	24	10,293	-
2009	159	213	50	286	3,546	371	63	3,179	67	7,934	-
2010	302	182	93	192	3,474	332	52	4,187	29	8,843	964
2011	138	449	95	206	3,733	418	44	2,712	41	7,836	643
2012	139	214	59	270	3,332	160	54	2,972	39	7,239	410
2013	118	235	94	276	3,326	638	91	5,473	35	10,286	485
2014	89	151	88	252	1,743	231	56	5,145	70	7,825	401
2015	126	334	115	263	1,430	158	-	3,241	78	5,745	424
2016 [2]	144	332	113	310	1,504	219	*39*	*6,746*	*96*	*9,503*	471
AVERAGES:											
1975-79	217	-	65	812	3,070	242	71	2,461	20	6,957	-
1980-89	158	-	43	301	2,768	379	162	2,320	11	6,142	-
1990-99	107	404	74	187	2,355	358	166	3,527	8	7,064	-
2000-09	205	401	75	224	2,873	247	118	4,683	22	8,849	-
2010-16	151	271	94	253	2,649	308	56	4,354	55	8,182	543
1975-06	163	364	69	308	2,711	314	126	3,526	21	7,443	-

[1] Those permittees reporting hunting cranes 1 or more times

[2] Preliminary

Table C-5. Estimated retrieved harvests of mid-continent sandhill cranes in the U.S. (Dubovsky 2017).

											Other Survey Areas				US
YR	CO	KS	MT	NM	ND	OK	SD	TX	WY	CENTRAL FLYWAY	AZ[4]	NM[4]	AK[2 3]	MN	TOTAL
1975	91	-	16	911	2,122	142	86	6,123	6	9,497	-	-	1,094	-	10,591
1976	106	-	29	858	52	200	12	6,122	14	7,393	-	-	637	-	8,030
1977	39	-	18	1,456	4,078	410	47	6,094	9	12,151	-	-	471	-	12,622
1978	106	-	36	1,089	2,777	389	19	5,720	10	10,146	-	-	239	-	10,385
1979	129	-	14	1,170	2,733	397	19	5,917	0	10,379	-	-	517	-	10,869
1980	68	-	16	1,019	2,245	363	130	6,305	6	10,152	-	-	809	-	10,961
1981	92	-	11	907	2,395	397	78	6,245	9	10,134	20	-	383	-	10,537
1982	49	-	21	335	2,469	535	212	4,295	0	7,916	62	-	1,160	-	9,138
1983	70	-	28	354	6,471	373	177	5,471	15	12,959	17	-	1,540	-	14,516
1984	85	-	15	414	4,367	433	139	5,811	7	11,271	23	-	1,986	-	13,280
1985	82	-	7	334	4,650	416	101	7,184	2	12,776	48	-	1,197	-	14,021
1986	33	-	1	250	6,563	392	99	5,149	0	12,487	108	184	539	-	13,318
1987	86	-	15	159	5,334	957	99	6,117	3	12,770	127	318	836	-	14,051
1988	68	-	18	372	3,815	1,061	100	7,330	8	12,772	172	127	1,241	-	14,312
1989	25	-	33	319	4,656	1,003	194	7,400	9	13,639	126	138	545	-	14,448
1990	87	-	44	377	6,804	698	165	9,865	1	18,041	114	259	918	-	19,332
1991	224	-	31	593	4,580	604	128	6,916	3	13,079	172	235	677	-	14,163
1992	84	-	103	505	4,654	478	141	6,455	13	12,433	139	54	640	-	13,266
1993	112	602	95	506	6,985	826	110	8,769	0	18,005	113	178	201	-	18,497
1994	143	767	56	357	6,235	1,167	239	7,233	4	16,201	86	153	648	-	17,088
1995	208	990	156	673	7,017	1,091	170	10,322	1	20,628	124	111	812	-	21,675
1996	91	933	58	332	6,639	1,066	166	7,816	10	17,111	114	78	1,205	-	18,508
1997	168	1,167	45	248	6,545	600	189	10,800	4	19,766	171	45	870	-	20,852
1998	64	1,362	17	258	7,967	645	454	9,054	10	19,831	114	55	1,042	-	21,042
1999	56	1,455	29	321	5,748	879	184	8,469	8	17,149	92	101	-	-	17,162
2000	363	590	15	311	5,081	552	374	8,208	10	15,504	166	100	985	-	16,755
2001	257	1,033	43	297	5,173	713	478	6,999	7	15,000	154	106	936	-	16,196
2002	294	1,067	23	342	2,852	490	160	7,837	22	13,087	197	92	844	-	14,220
2003	230	942	49	617	4,564	200	166	11,560	7	18,335	155	162	331	-	18,983
2004	92	856	54	350	3,967	441	67	8,715	4	14,546	192	167	435	-	15,340
2005	265	471	65	578	3,721	511	190	12,446	16	18,263	227	175	388	-	19,053
2006	96	1341	12	682	3,906	538	202	10,834	20	17,631	201	245	314	-	18,391
2007	149	516	51	427	4,501	272	163	12,511	20	18,610	268	331	596	-	19,805
2008	32	453	73	483	4,179	493	83	17,169	24	22,989	138	329	1249	-	24,705
2009	58	447	34	584	4,436	737	96	8,882	8	15,282	305	332	245	-	16,164
2010	115	293	95	432	4,752	940	91	12,069	25	18,812	253	421	1204	830	21,520
2011	68	908	51	297	3,733	808	64	8,493	20	14,442	151	367	335	765	16,060
2012	77	437	30	388	3,019	401	185	10,309	41	14,887	300	341	1360	407	17,295
2013	47	771	77	326	4,137	1085	109	14,991	41	21,584	138	161	930	378	23,191
2014	41	176	114	269	2,924	390	85	11,740	37	15,776	151	123	1123	247	17,420
2015	98	1005	91	267	2,133	302	-	8,283	28	12,207	311	132	-	212	12,862
2016[1]	102	873	111	660	2,507	538	183	18,196	83	23,253	292	404	1036	287	25,272
AVERAGES:															
1975-79	94	-	23	1,097	2,352	308	37	5,995	8	9,913	-	-	592	-	10,506
1980-89	66	-	17	446	4,297	593	133	6,131	6	11,688	78	192	1,024	-	12,858
1990-99	124	1,014	63	417	6,317	805	195	8,570	5	17,206	124	127	779	-	18,159
2000-09	184	772	42	467	4,238	495	198	10,516	14	16,925	200	204	632	-	17,961
2010-16	78	638	81	377	3,315	638	120	12,012	39	17,280	228	278	998	447	19,089
1975-16	113	803	45	510	4,369	594	150	8,720	13	14,969	154	194	813	-	16,093

[1] Preliminary

[2] A proportion of the Alaskan harvest is composed of lesser sandhill cranes from the Pacific Flyway population

[3] Harvest data are from state harvest surveys for only the MCP portion of the state, except in 1977-81, 1986, 1991, and 1998-99 (shaded cells) where federal MQS state totals are prorated by the long-term percent MC cranes; data from 2000 forward are MC portion from HIP

[4] The MC harvest for AZ and NM represents MC sandhill cranes that were harvested in RMP areas and are not represented in the CF MC sandhill crane federal harvest survey

Table C-6. Estimated retrieved harvests of mid-continent sandhill cranes in Canada (Dubovsky 2017).

YEAR	MB	SK	TOTAL
1971	228	2,715	2,943
1972	113	2,030	2,143
1973	683	3,592	4,275
1974	58	6,641	6,699
1975	164	6,000	6,164
1976	210	1,425	1,635
1977	367	N/A	367
1978	876	N/A	876
1979	977	2,821	3,798
1980	892	4,690	5,582
1981	508	2,451	2,959
1982	796	2,041	2,837
1983	378	2,720	3,098
1984	674	3,043	3,717
1985	691	4,468	5,159
1986	1,651	4,455	6,106
1987	795	4,472	5,267
1988	1,955	4,991	6,946
1989	2,666	2,318	4,984
1990	1,018	3,821	4,839
1991	1,800	3,594	5,394
1992	1,205	4,440	5,645
1993	482	2,309	2,791
1994	529	3,259	3,788
1995	1,005	4,824	5,829
1996	1,352	2,961	4,313
1997	1,279	4,622	5,901
1998	889	8,636	9,525
1999	1,300	7,100	8,400
2000	805	8,645	9,450
2001	1,247	7,538	8,785
2002	1,283	6,665	7,948
2003	1,474	8,111	9,585
2004	1,267	9,770	11,037
2005	1,776	8,100	9,876
2006	2,688	7,729	10,417
2007	3,554	8,232	11,786
2008	742	8,697	9,439
2009	1,037	3,128	4,165
2010	1,051	6,280	7,331
2011	2,450	7,981	10,431
2012	644	4,397	5,041
2013	1,344	8,539	9,883
2014	3,064	9,748	12,812
2015	1,207	9,397	10,604
2016	1,640	9,863	11,503
AVERAGES:			
1971-79	408	3,567	3,183
1980-89	1,086	3,564	4,650
1990-99	1,086	4,594	5,680
2000-09	1,587	7,662	9,249
2010-16	1,629	8,029	9,658
1971-16	1,145	5,440	6,349

Table C-7. Annual sport hunting mortality estimates for the mid-continent population of sandhill cranes in North America (Dubovsky 2017).

	SPORT HUNTING MORTALITY					
	Retrieved				Unretrieved	Total
Year	Central Flyway	Pacific Flyway	Canada	Mexico[2]	No. Am.[3]	
1975	9,497	1,094	6,164	1,676	3,672	22,102
1976	7,393	637	1,635	967	2,032	12,663
1977	12,151	471	367	1,299	2,440	16,728
1978	10,146	239	876	1,126	2,308	14,695
1979	10,379	517	3,798	1,469	2,807	18,970
1980	10,152	809	5,582	1,654	3,349	21,546
1981	10,134	403	2,959	1,350	2,722	17,568
1982	7,916	1,222	2,837	1,198	2,451	15,624
1983	12,959	1,557	3,098	1,761	3,503	22,879
1984	11,271	2,009	3,717	1,700	3,375	22,072
1985	12,776	1,245	5,159	1,918	3,524	24,622
1986	12,487	831	6,106	1,942	3,646	25,012
1987	12,770	1,281	5,267	1,932	3,406	24,656
1988	12,772	1,540	6,946	2,126	3,750	27,134
1989	13,639	809	4,984	1,943	3,628	25,003
1990	18,041	1,291	4,839	2,417	4,228	30,817
1991	13,079	1,084	5,394	1,956	3,455	24,967
1992	12,433	833	5,645	1,891	3,133	23,935
1993	18,005	492	2,791	2,129	3,334	26,751
1994	16,201	887	3,788	2,088	3,029	25,992
1995	20,628	1,047	5,829	2,750	4,161	34,416
1996	17,111	1,397	4,313	2,282	3,609	28,713
1997	19,766	1,086	5,901	2,675	4,211	33,640
1998	19,831	1,211	9,525	3,057	4,901	38,524
1999	17,149	193	8,400	2,574	3,950	32,267
2000	15,504	1,251	9,450	2,621	4,093	32,919
2001	15,000	1,201	8,785	2,499	4,014	31,499
2002	13,087	1,139	7,948	2,217	3,448	27,839
2003	18,335	647	9,586	2,857	4,246	35,671
2004	14,546	794	11,037	2,638	4,165	33,179
2005	18,263	790	9,876	2,893	4,512	36,334
2006	17,631	760	10,417	2,881	4,864	36,552
2007	18,610	1,195	11,786	3,159	4,904	39,654
2008	22,989	1,716	9,439	3,414	4,432	41,990
2009	15,282	882	4,165	2,033	3,100	25,462
2010	18,812	2,708	7,331	2,885	4,400	36,136
2011	14,442	1,618	10,431	2,649	4,006	33,146
2012	14,887	2,408	5,041	2,234	3,397	27,966
2013	21,584	1,607	9,883	3,307	4,188	40,570
2014	15,776	1,644	12,812	3,023	4,521	37,776
2015	12,207	655	10,604	2,347	3,652	29,465
2016 [1]	23,253	2,019	11,503	3,678	4,460	44,912
AVERAGES:						
1975-79	9,913	592	2,517	1,307	2,641	16,965
1980-89	11,688	1,171	4,650	1,751	3,332	22,591
1990-99	17,206	1,036	5,680	2,384	3,809	30,032
2000-09	16,925	1,037	9,249	2,721	4,177	34,108
2010-16	17,280	1,808	9,658	2,875	4,089	35,710
1975-16	14,969	1,147	6,571	2,266	3,691	28,622

[1] Preliminary

[2] Unknown harvests (Mexico) were assumed to be 10% of harvests in the U.S. and Canada.

[3] Unretrieved kill as reported by hunters is used for the Central Flyway; for the remainder of harvest areas, it is assumed to be 20% of retrieved harvests.

Table C-8. Mid-continent sandhill crane abundance indices from eight strata surveyed in Alaska and Yukon Territory during the Waterfowl Breeding Population and Habitat Survey, 1964–2017[a].

Year	Tanana-Kuskokwim (Stratum 3)	Yukon Flats (Stratum 4)	Innoko (Stratum 5)	Koyukuk (Stratum 6)	Yukon-Kuskokwim Delta (Stratum 9)	Seward Peninsula (Stratum 10)	Kotzebue Sound (Stratum 11)	Old Crow Flats, YT (Stratum 12)	Total
1964	155	0	309	51	19,486	321	764	0	21,086
1965	141	771	77	0	13,607	1,444	1,226	0	17,266
1966	141	711	618	102	13,812	1,123	1,672	0	18,179
1967	1,079	540	464	192	16,778	160	780	0	19,993
1968	775	945	695	205	19,541	2,406	2,006	0	26,573
1969	493	270	618	308	32,738	2,085	1,115	109	37,736
1970	2,959	1,485	464	871	33,557	962	892	0	41,190
1971	1,198	810	773	717	31,511	1,283	1,783	0	38,075
1972	845	945	1,082	359	18,211	802	1,449	0	23,693
1973	352	540	1,082	461	19,029	1,444	1,560	0	24,468
1974	916	675	1,082	359	17,085	1,604	2,452	0	24,173
1975	0	270	0	154	20,973	1,444	2,229	0	25,070
1976	282	0	309	0	17,085	962	446	0	19,084
1977	1,057	2,565	1,314	871	34,989	3,048	1,003	0	44,847
1978	916	675	309	359	27,930	1,765	1,560	0	33,514
1979	775	540	464	564	38,672	7,425	5,796	0	54,236
1980	282	945	1,468	769	26,907	1,375	3,790	0	35,536
1981	423	3,105	773	717	24,042	7,563	2,452	164	39,239
1982	845	1,215	1,700	2,204	32,738	17,325	4,012	55	60,094
1983	1,127	675	695	769	25,986	8,387	6,353	55	44,047
1984	423	2,025	309	820	28,646	5,088	2,786	0	40,097
1985	493	1,215	1,468	974	29,362	5,637	3,344	55	42,548
1986	211	2,295	155	308	22,815	12,512	3,232	164	41,692
1987	564	1,485	232	308	27,828	2,063	4,124	109	36,713
1988	70	1,215	1,236	1,025	25,372	1,925	3,790	164	34,797
1989	564	4,320	464	1,384	23,633	3,300	5,573	0	39,238
1990	634	1,080	695	1,384	32,636	3,300	5,573	0	45,302
1991	775	1,620	695	717	25,884	6,188	4,681	55	40,615
1992	211	945	1,545	871	25,168	12,512	4,681	109	46,042
1993	493	945	1,159	1,025	28,339	6,050	4,124	0	42,135
1994	352	2,025	232	717	28,953	13,750	4,235	55	50,319
1995	282	1,215	541	1,230	29,158	7,838	3,455	109	43,828
1996	211	1,890	155	1,076	30,795	5,363	4,235	0	43,725
1997	845	2,160	232	1,128	31,715	3,713	4,458	164	44,415
1998	423	3,240	1,082	615	29,772	7,975	3,009	0	46,116
1999	211	405	1,545	871	22,201	3,987	4,793	0	34,013
2000	1,268	1,755	541	1,435	18,211	5,225	7,245	109	35,789
2001	1,292	540	695	1,384	34,580	6,325	5,796	0	50,612
2002	705	1,350	386	564	19,541	7,563	2,341	55	32,505
2003	1,268	1,485	232	769	23,224	5,088	3,567	0	35,633
2004	986	1,485	386	2,255	22,508	9,212	2,564	0	39,396
2005	564	1,080	541	564	22,303	2,200	3,121	274	30,647
2006	423	405	155	820	36,319	4,675	6,130	109	49,036
2007	564	945	232	923	27,725	6,050	2,452	109	39,000
2008	1,057	1,385	1,082	1,230	33,920	5,225	4,124	55	48,078
2009	916	1,215	927	1,691	37,956	4,125	5,127	109	52,066
2010	727	1,080	155	1,691	34,273	4,262	4,904	0	47,092
2011	1,691	1,485	1,777	1,230	28,748	3,713	6,242	109	44,995
2012	423	1,350	464	1,691	29,976	7,838	7,691	164	49,597
2013	845	135	386	1,507	14,016	7,150	4,458	0	28,497
2014	0	540	927	205	10,026	7,150	3,344	274	22,466
2015	258	270	0	615	12,139	1,765	1,783	109	16,939
2016	564	0	0	308	21,894	5,225	2,898	766	31,655
2017	282	0	0	820	28,442	7,425	5,573	0	42,542

[a]Index = singles + (2 x pairs) + birds in flocks. Indices are not adjusted to account for incomplete detection by observers.