



U.S. Fish & Wildlife Service

# Status and Harvests of Sandhill Cranes

*Mid-continent, Rocky Mountain, Lower Colorado River Valley and Eastern Populations*

**2019**



## **Acknowledgments**

This report provides population status, recruitment indices, harvest trends, and other management information for the Mid-Continent (MCP), Rocky Mountain (RMP), Lower Colorado River Valley (LCRVP), and Eastern (EP) populations of sandhill cranes. Information was compiled with the assistance of a large number of biologists from across North America. We acknowledge the contributions of: T.S. Liddick, P.P. Thorpe, D.P. Collins, P. Donnelly, J.L. Drahota, and D.L. Fronczak for conducting annual aerial population surveys; W.M. Brown and K.K. Kruse for conducting the RMP productivity survey; D. Johnson and J. Steiner for statistical assistance and photo interpretation, respectively, in developing the MCP spring population estimates; K.K. Fleming and M.H. Gendron for conducting the U.S. and Canadian Federal harvest surveys for the MCP; S. Olson and J. O'Dell for compiling population and harvest information collected on sandhill cranes in the Pacific Flyway; T. Cooper, R. Pierce and D.L. Fronczak for compiling population information for the EP; and D.S. Benning, R.C. Drewien and D.E. Sharp for their career-long commitment to sandhill crane management. We especially want to recognize the support of the state and provincial biologists in the Central, Pacific, and Mississippi Flyways for the coordination of sandhill crane hunting programs and especially the distribution of crane hunting permits and assistance in conducting of annual cooperative surveys. T. Cooper and D.P. Collins reviewed a draft of this document.

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# STATUS AND HARVESTS OF SANDHILL CRANES

## MID-CONTINENT, ROCKY MOUNTAIN, LOWER COLORADO RIVER VALLEY and EASTERN POPULATIONS 2019

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*Abstract:* The U.S. Fish and Wildlife Service, working with partners, annually assesses the population status and harvest of four populations of Sandhill cranes: the Mid-continent, Rocky Mountain, Lower Colorado River, and Eastern populations. The annual indices to abundance of the Mid-Continent Population (MCP) of sandhill cranes had been relatively stable from 1982 to the mid-2000s. Some of the annual indices have increased in recent years, and are more variable interannually compared to historic values. The spring 2019 estimate of abundance for sandhill cranes in the Central Platte River Valley (CPRV), Nebraska, corrected for visibility bias, was 945,996 birds. This estimate is 6% below the record-high estimate from the previous year, and the second-highest recorded. The photo-corrected, 3-year average for 2017-19 was 839,992, which is well above the established population-objective range of 350,000-475,000 cranes. All Central Flyway States, except Nebraska, allowed crane hunting in portions of their States during 2018-19. An estimated 12,631 Central Flyway hunters participated in these seasons, which was 19% higher than the number that participated in the previous season and a record-high estimate. Hunters harvested 30,175 MCP cranes in the U.S. portion of the Central Flyway during the 2018-19 seasons, which was a record high and 94% higher than the long-term average. The estimated retrieved harvest of MCP cranes in hunt areas outside of the Central Flyway (Arizona, Pacific Flyway portion of New Mexico, Minnesota, Alaska, Canada, and Mexico combined) was 19,200 birds during 2018-19. The preliminary estimate for the North American MCP sport harvest, including crippling losses, was 54,678 birds, which was a 6% increase from the previous year's estimate and a record for the third consecutive year. The long-term (1982-2017) trends for the MCP indicate that harvest has been increasing at a higher rate than population growth. The fall 2018 pre-migration survey for the Rocky Mountain Population (RMP) resulted in a count of 21,801 cranes, 11% higher than the count from 2017. The 3-year average was 21,219 sandhill cranes, which is slightly above the established population objective of 17,000-21,000 for the RMP. Hunting seasons during 2018-19 in portions of Arizona, Idaho, Montana, New Mexico, Utah, and Wyoming resulted in a harvest of 1,524 RMP cranes, a 28% increase from the previous year's harvest. The Lower Colorado River Valley Population (LCRVP) survey results indicate a 22% increase from 2,396 birds in 2018 to 2,922 birds in 2019. The 3-year average is 2,678 LCRVP cranes, which is slightly above the population objective of 2,500 birds. The Eastern Population (EP) sandhill crane fall survey index for 2018 (97,751) was a 37% increase from the previous year, and still well above the objective of 30,000 cranes for this population. A total of 615 cranes were harvested in Kentucky and Tennessee during the 2018-19 seasons.

## Introduction

The MCP of sandhill cranes, numerically the most abundant of all North American crane populations, is comprised of lesser (*Antigone canadensis canadensis*) and greater (*A. c. tabida*) subspecies of sandhill cranes. A third, intermediate-sized subspecies, the Canadian sandhill crane (*A. c. rowanii*), was identified in the MCP (Walkinshaw 1965); however, genetic investigations question the differentiation of this third subspecies (Rhymer et al. 2001, Peterson et al. 2003, Jones et al. 2005). The breeding range extends from northwestern Minnesota, northern Ontario and western Quebec, then northwest through Arctic Canada, Alaska, and into eastern Siberia. The MCP wintering range includes western Oklahoma, New Mexico, southeastern Arizona, Texas, and northern portions of Mexico (Fig. 1). Extensive spring aerial surveys on major concentration areas that are corrected for observer visibility bias provide annual indices of abundance used to measure population trends. These surveys are conducted in late March, at a time when birds that wintered in Mexico, Arizona, New Mexico, and Texas usually have migrated northward to spring staging areas, but before spring "break-up" conditions allow cranes to move into Canada (Benning and Johnson 1987). The MCP Cooperative Flyway Management Plan (Central, Mississippi and Pacific Flyway Councils 2018) established regulatory thresholds for changing harvest regulations that are based on an objective of maintaining sandhill crane abundances at 1982-2005 levels (i.e., spring index of 349,000–472,000 [ $\bar{x} = 411,000 \pm 15\%$ ]), rounded up to the nearest 5,000 birds. Sandhill crane hunters are required to obtain either a Sandhill Crane hunting permit or register under the Harvest Information Program (HIP) to hunt MCP cranes in the U.S. portion of the Central Flyway, Minnesota in the Mississippi Flyway, and Alaska. The permits or HIP registration records provide the sampling frame to conduct annual harvest surveys. In Canada, the harvest survey is based on the sales of Federal Migratory Bird Hunting Permits, which are required for all crane hunters.

The RMP is comprised exclusively of greater sandhill cranes that breed in isolated river valleys, marshes, and meadows of the U.S. portions of the Central and Pacific Flyways (Drewien and Bizeau 1974). The highest nesting concentrations are located in western Montana and Wyoming, eastern Idaho, northern Utah, and northwestern Colorado. The RMP migrates through the San Luis Valley (SLV) in Colorado and winters primarily in the Middle Rio Grande Valley, New Mexico, with smaller numbers wintering in the southwestern part of New Mexico, in southeastern Arizona, and at several locations (~14) in the Northern Highlands of Mexico (Fig. 2). During 1984-96, the RMP was monitored at spring stopover areas in the SLV. However, cranes from the MCP also began to use this area, which confounded estimates of RMP abundance. In 1995, a fall pre-migration (September) survey replaced the spring count as the primary tool for monitoring population change. The RMP Cooperative Flyway Management Plan established a population objective (17,000-21,000 birds), and identifies surveys used to monitor recruitment and harvest levels that are designed to maintain a stable abundance (Pacific Flyway Council and Central Flyway Council 2016). The plan contains a formula for calculating allowable annual harvests consistent with the goal of staying within the range of the population objective. All sandhill crane hunters in the range of the RMP must obtain a state permit to hunt cranes, which provides the sampling frame for independent harvest estimates and allows for assignment of harvest quotas by state. In many areas, harvest estimates are supplemented by periodic mandatory check-station reporting.

The LCRVP is numerically the least abundant of the six migratory populations of sandhill cranes recognized in the U.S. (Drewien et al. 1976, Drewien and Lewis 1987). The LCRVP is comprised exclusively of greater sandhill cranes that breed primarily in northeastern Nevada, with smaller numbers in parts of Idaho and Utah (Fig. 3), and winters largely in the Colorado

River Valley of Arizona and Imperial Valley of California (Grisham et al. 2018). LCRVP cranes have the lowest reported recruitment rate (4.8%) of any sandhill crane population in North America (Drewien et al. 1995). In the fall, these cranes leave breeding areas during late September-early October, congregate at several staging areas, and migrate through eastern Nevada to wintering areas. Wintering areas historically extended south along the Colorado River to near its delta with the Gulf of California. However, the current wintering distribution is concentrated at Cibola National Wildlife Refuge, on adjacent areas belonging to the Colorado River Indian Tribes in southwestern Arizona, areas within and near the Sonny Bono Salton Sea NWR in southern California, and the Gila River in Arizona. Collectively, these areas are believed to winter in excess of 90% of the total cranes in the LCRVP. Spring migration is generally initiated as early as the first week of February. Since 1998, an aerial cruise survey has been conducted that covers the four main winter concentration areas.

The EP, which consists of greater sandhill cranes, has rebounded from near extirpation in the late 1800's (Walkinshaw 1949, 1973; Leopold 1949). Management actions, such as regulating take and the protection and restoration of habitat, allowed this population to increase to a level that exceeded 30,000 cranes by 1996 (Meine and Archibald 1996). The majority of EP cranes breed across the Great Lakes region (Wisconsin, Michigan, Ontario, and Minnesota); however, the range of this population is currently expanding in all directions (Fig. 4)(Lacy et al. 2015). By early fall, EP cranes leave their breeding grounds and congregate in large flocks on traditional staging areas throughout the breeding range. During migration, EP cranes use traditional stopover areas which include Jasper-Pulaski Fish and Wildlife Area in northwest Indiana and Hiawassee State Wildlife Refuge in southeast Tennessee. Historically, EP cranes primarily wintered in southern Georgia and throughout Florida (Walkinshaw 1973, Lewis 1977, Tacha et al. 1992, Meine and Archibald 1996). Recent annual Midwinter Survey data, conducted by state and federal agencies, show substantial numbers of cranes wintering farther north into Kentucky, Tennessee, and even Indiana in some years (2013-2019 U.S. Fish and Wildlife Service [unpublished data], Fronczak et al. 2017, Urbanek 2018).

## **Mid-Continent Population of Sandhill Cranes**

No sport hunting seasons for MCP cranes were allowed in the U.S. between 1918-60. In the Central Flyway, areas open to hunting were gradually expanded during 1961-74, but since that time have remained relatively stable. Operational hunting seasons are now held annually in portions of Colorado, Kansas, Montana, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Wyoming. Nebraska is the only Central Flyway state that does not have a sandhill crane sport hunting season. Areas open to crane hunting in the Central Flyway during 2018-2019 are shown in Fig. 5. Beginning in 2010, Minnesota, a Mississippi Flyway state, opened a limited hunt in the northwest portion of the state.

During 1961-74, hunters gradually improved their knowledge of sandhill cranes and improved their hunting success. During 1975-85, a tradition of sandhill crane hunting became established. Together with improvements in equipment (decoys, calls, clothing, blinds, etc.) and a shift from pass-shooting and hunting on roosts to decoy-hunting in fields, crane hunter success increased (Sharp and Vogel 1992). Dubovsky and Araya (2008) found that in the late 1990s and early 2000s hunters were more successful in harvesting 2 or 3 cranes per day than they were during the early 1980s. Average seasonal bags declined in the Central Flyway during the late 1990s and early 2000s, but during the last few seasons has increased to levels observed in the late 1980s to late 1990s (Fig. 13).

For most states, sandhill crane seasons began in relatively small areas, and expanded incrementally in subsequent years as experience with the seasons was gained. For example, sandhill crane seasons in North Dakota resumed in 1968 after being closed following the signing of the Migratory Bird Treaty Act in 1918. During 1968-79, the number of counties open for crane hunting increased from 2 to 8, and increased to 30 during 1980-92 and were grouped into two zones that were west of Highway 281. Beginning in 1993, the zones were eliminated and Federal frameworks were fully utilized for the designated hunting area (Sharp and Cornely 1997). In 2001, designated hunt areas in North Dakota and Texas were expanded, with the new areas having reduced frameworks of 37 days compared to 58 in other areas and also a reduced daily bag. In 2014, North Dakota increased season length in the eastern zone to 58 days but kept the 2 bird daily bag limit; harvest data suggested there would be negligible effects on that segment of the population. Kansas was the most recent Central Flyway state to initiate a crane hunting season in 1993. Initially, crane hunting was open only in portions of 17 counties, but by 2003 the area was expanded to 62 counties, essentially the entire western portion of the state (Sharp et al. 2010). Also, during early years of these seasons, bag limits and shooting hours often were more restrictive than Federal frameworks allowed.

MCP harvest areas have remained relatively consistent from year to year; however, the levels of harvest vary with respect to many factors including changes in hunting pressure, land use, and environmental factors. Most shifts in annual harvests occur locally, but large-scale changes in harvest distributions also have occurred. Since the late 1990s, the annual harvest has generally increased in Saskatchewan, while harvest has declined in North Dakota (Fig. 6). Causal factors for these changes have not been determined, but are likely different because birds staging in Saskatchewan are largely from the West-central Canada-Alaska breeding affiliation whereas those in North Dakota are from the East-central Canada-Minnesota breeding affiliation (Krapu et al. 2011). Increased hunting pressure in Saskatchewan, mainly by non-resident U.S. hunters (Araya et al. 2010), has likely contributed to increases in harvests whereas declines in harvests in North Dakota appear to be more complex and involve several interrelated factors, likely including changes in hunting pressure, land-use changes, and environmental conditions.

The MCP included at least 510,000 sandhill cranes in March 1982, the last extensive survey involving high-altitude vertical photography of major spring migration staging concentrations. Beginning in 1982, an intensive photo-corrected ocular-transect survey of Nebraska's CPRV and ocular assessments from other spring staging areas have been used to monitor the annual status and trends for this population (Table 1). Use of the CPRV count in the development of annual harvest recommendations relies on the premise that a high proportion (>90%) of the MCP are in the CPRV at the time of the annual survey. Recent research with radio-tracked birds suggests that the proportion of MCP cranes in the CPRV during the survey varies by year (Pearse et al. 2015). Annual variability in weather patterns can reduce the percentage below 90% in some years. However, conducting the survey a few days earlier or a few days later likely would not result in a 'better' count (i.e., a higher proportion of birds being in the CPRV), because birds migrate into and out of the area continuously (Pearse et al. 2015).

The March 2019 photo-corrected ocular estimate for the CPRV was 945,996 cranes (Table 1, Fig. 7), 6% lower than the count from March 2018 (1,005,612), which was a record-high count (Liddick 2019). The natural log-transformed annual photo-corrected estimates for the CPRV portion of the survey suggest an increasing population trend ( $P = 0.03$ ) since 2006 due to the higher counts in several of the recent surveys (Fig. 8); however, estimates also have more interannual variability in recent years relative to historic values, resulting in a poor fit of the trend to the data ( $R^2 = 0.33$ ). The 3-year-average index for photo-corrected estimates in the CPRV during 2017-19 is 839,992 cranes, which is 27% higher than the previous 3-year average of

659,899 and well above the management objective level (350,000-475,000) for this population (Fig. 9).

Since 1975, special Sandhill Crane Hunting Permits, or more recently HIP certification, have been required for crane hunters participating in seasons in the Central Flyway. Additionally, a limited MCP sandhill crane hunt was offered in Minnesota starting in 2010, for which a state-issued permit is required for hunters to participate. A sample of these permittees is mailed questionnaires soon after the completion of each hunting season. The resulting responses enable estimation of hunting activities and success (Martin 2007). Estimated numbers of hunters registering as sandhill crane hunters in Texas had been increasing since 1997 when crane hunting was included in the combination licenses issued by the state, with a record high of 122,553 permits issued in 2008. In 2009, Texas revised their licensing system and crane hunters now must go to selected locations to obtain their permit, which resulted in a 91% decrease in the number of hunters identified as crane hunters from 2008. Thus, the number of crane hunters in Texas likely did not decrease as suggested by the data; rather, the number of hunters classified as crane hunters by the Texas registration process declined. During the 2018-19 season in the Central Flyway, 41,762 hunters were either HIP-certified or obtained crane hunting permits, which were not limited in number (Table 2), with 12,631 of these individuals hunting at least one time (Table 3, Fig. 10). The number of active hunters in the Central Flyway was 19% higher than the previous year (Fig. 10). During 2018-19, the number of hunters in Texas (70%) and North Dakota (13%) combined comprised 83% of all sandhill crane hunters in the Central Flyway. Minnesota issued 1,954 permits and had 964 active hunters in their first season but participation has declined over the subsequent several years and is perhaps leveling out. In 2018, Minnesota issued 1,091 permits and had 383 active hunters (3% and 4% decreases, respectively, from 2017).

Federal frameworks for most areas in the Central Flyway allow daily bag/possession limits of 3/9, which most states selected. Portions of North Dakota, Texas and Minnesota have had lower bag and possession limits of 2/6; the bag/possession limit in Minnesota was lowered to 1/3 for the 2018-19 season. Specific dates selected by states in the Central Flyway and Minnesota for 2018-19 were similar to those of previous hunting seasons (Table 4).

An index to crippling-loss rate (number of cranes lost/[number of cranes lost + retrieved]) in the U.S. portion of the Central Flyway has declined ( $R^2 = 0.90$ ,  $P < 0.01$ ) from over 16% in 1975 to a preliminary estimate of about 4.6% during the most recent hunting season (Fig. 11). The number of days afield per hunter (2.62) was essentially the same as that from the previous year (Fig. 12) and was 15% lower than the long-term average of 3.07. The preliminary estimate of seasonal bag per hunter was 2.39 birds (Fig. 13), which is 18% higher than the long-term average of 2.03. The preliminary estimate of retrieved and unretrieved mortality associated with the sport harvest in the Central Flyway (31,638) was 13% higher than the previous year's estimate (Fig. 14). The increasing trend ( $R^2 = 0.49$ ,  $P < 0.01$ ) in the Central Flyway's harvest of MCP cranes during 1975-2018 likely is related to improved knowledge of crane behavior, hunting techniques, and hunter success (Sharp and Vogel 1992, Dubovsky and Araya 2008), and increased numbers of cranes available for harvest in recent years due to growth in the MCP.

Cranes from the MCP also occur in the RMP hunt areas in Arizona, New Mexico, Alaska (Table 5), Canada, and Mexico. The estimate for the 2018-19 sport harvest in Canada (Manitoba and Saskatchewan) was 13,006 birds, a 3% decrease from that of last year (Table 6). For Alaska, sandhill cranes harvested in Game Management Units (GMUs) 11-13 and 18-26 are believed to be MCP cranes, while cranes harvested in GMUs 1-10 and 14-17 are believed to be Pacific

Coast Population cranes. There also is some intermingling of MCP cranes with RMP cranes in portions of New Mexico and Arizona; however, periodic bag checks allow estimates of harvests for each population. The estimated harvest for the RMP hunt areas in Arizona, New Mexico, and Alaska combined was 1,576 cranes for 2018-19. In the 9th year of Minnesota's sandhill crane hunt the harvest (129 cranes) decreased by 34% from the previous year. No annual harvest surveys are conducted in Mexico, but annual MCP harvests probably are <10% of the retrieved harvest in the U.S. and Canada (R. Drewien and D. Nieman, personal communication). This assumed low level of harvest was supported by an independent assessment of harvest in Mexico (Kramer et al. 1995). The 2018-19 preliminary estimate of retrieved and unretrieved kill of MCP cranes by sport hunters was a record high of 54,678, which is a 6% increase from the previous year and a 60% increase from the average for 2000-09 (Table 7, Fig. 15).

To assess the relative rates of change between population size (abundance) and harvest, we periodically assess trends in these parameters. In the most recent analysis we used linear regression on the natural log-transformed values for these variables for the years 1982-2017. Because >10% of the MCP occurs outside the CPRV in the spring of some years, we combined the photo-corrected counts in the CPRV with the ocular cruise estimates from areas outside the CPRV for analyses of population abundance. For harvest, we used only the estimates of 'retrieved' harvest for the Central Flyway, Minnesota, and MCP cranes harvested in hunt areas in Arizona and New Mexico, Alaska, and Canada, because crippling-loss rates for the latter three areas are unknown and there are no empirical estimates of harvest from Mexico. Regression of the log-transformed values indicate a significant slope for the abundance values ( $P < 0.01$ ;  $R^2 = 0.21$ ; slope = +1.1% per year change), suggesting a slightly increasing trend in the abundance of cranes over the time frame. The regression of the harvest values also indicates an increase in the rate of harvest over that same time period ( $P < 0.01$ ;  $R^2 = 0.63$ ; slope = +1.9% per year) (Fig. 16). These results are fairly consistent with results from the last time this analysis was updated (slope[abundance]<sub>1982-2012</sub> = 0.8; slope[harvest]<sub>1982-2012</sub> = 1.8) and continue to suggest that the increase in the rate of harvest is increasing faster than the rate of growth in crane abundance. Methods have been developed (e.g., Araya and Dubovsky 2008, Dubovsky and Araya 2008) that may assist managers in structuring changes in harvest regulations should such a need arise in the future. Results suggest that a bag-limit reduction of one bird per day may reduce state-specific harvests by 4%-23%, whereas fairly large restrictions in season framework dates may be needed to realize a perceptible decrease in harvest. More recent analyses suggest a 1-bird reduction in the daily bag limit for all U.S. states harvesting MCP cranes would result in a 16.4% decrease in total harvest, whereas a 2-bird reduction would result in a 50.4% decrease in total harvest (Central, Mississippi and Pacific Flyway Councils 2018:Table A-4).

Subsistence harvest levels of MCP sandhill cranes historically were poorly documented. However, the 1997 U.S./Canada Migratory Bird Treaty Amendment identified improvements that should be made to sandhill crane harvest-monitoring programs in both the U.S. and Canada. Harvest surveys conducted during 2006-2017 on the Yukon-Kuskokwim (Y-K) Delta, Alaska, reported an average MCP harvest of 2,896 adults and fledged young and an average of 1,183 eggs (data from Naves and Keating 2019). The harvest estimate for birds is relatively similar to the 1985-2005 average (Wentworth 2007) of 3,151 adults and fledged young taken by subsistence hunters on the Y-K Delta, but that for eggs is 124% higher than the 1985-2005 average of 528 eggs. Efforts are being made to gather additional information on subsistence harvests for the remainder of Alaska, Siberia, and Canada.



## Rocky Mountain Population of Greater Sandhill Cranes

The RMP was not hunted in the U.S. from 1918-80. Arizona initiated the first modern-day season in 1981. Since that time hunting programs have been guided by a cooperative management plan, including a harvest strategy that has been periodically updated and endorsed by the Central and Pacific Flyways (Kruse et al. 2008). The harvest strategy for the RMP calculates an allowable harvest based on crane survey counts and recruitment relative to the population objective. Thus, allowable harvest changes annually based on the current status of the birds.

Counts conducted in the SLV during the spring migration suggested that the number of RMP cranes was relatively stable during 1984-96 (Table 8). However, survey biologists found that these estimates contained increasing numbers of the MCP (lesser subspecies). An adjustment, using ground-derived proportions, was made to correct for the lesser subspecies but was not a viable approach for the long-term (Benning et al. 1996). In 1996, the survey was discontinued (Fig. 18). In 1997, an attempt was made to survey these cranes during the fall (October) in the SLV, but MCP cranes also were present at that time. Biologists concluded that neither a spring nor a fall count in the SLV would result in a reliable index to the abundance of the RMP. As an alternative, a cooperative 5-state September pre-migration staging-area survey, experimentally tested in 1987 and 1992, has been ongoing operationally since 1995. Because no other crane population commingles with them during that time, the September pre-migration survey for the RMP appears to be a good alternative to either a spring or fall survey in the SLV and was designated as the official count for the RMP in 1997 (Table 9). Although operational in 1995 and 1996, the survey was variable in timing and survey effort. What appears to be lower population estimates (Fig. 18) in 1995 and 1996 is likely more an artifact of inconsistent survey effort (R. Drewien, personal communication).

The Cooperative Flyway Management Plan (Pacific Flyway Council and Central Flyway Council 2016) recommends using the most recent three-year running average of the September survey to determine status of the RMP. The 2018 September pre-migration survey resulted in 21,801 cranes counted, an 11% increase from the count in 2017 (Thorpe et al. 2018). The 3-year average is 21,219 which is 4% lower than the previous 3-year average (22,062) and slightly above the established population objective (17,000-21,000) (Fig. 19).

During 1986-95, important breeding areas in the Intermountain West experienced extremely dry conditions and indices of recruitment (% juveniles) were low (generally between 4-6%) (Fig. 20). A return to more favorable breeding conditions during 1996-99 resulted in higher recruitment rates (8-12%), but drier conditions resulted in lower production during 2000-02. Since 2003 recruitment rates generally have been above-average due to improved wetland habitats and favorable spring and summer breeding conditions. The recruitment rate of 7.9% (4% below the long-term [1972-2017] average of 8.2) and a mean brood size of 1.13 (Brown and Kruse 2018) indicated slightly lower-than-average nesting and brood-rearing habitat in 2018.

Special limited hunting seasons during 2018-19 resulted in a harvest of 1,524 RMP sandhill cranes (Table 8), which was 28% higher than last year and a record-high harvest (Fig. 17), but below the 2,168 allowed by the harvest strategy. Based on decreased average abundance and recruitment indices for the 2016-18 period (Figs. 19, 20), management guidelines allow for a maximum allowable take of 1,628 birds during the 2019-20 hunting season, a 25% decrease from that for the 2018-19 season.

## Lower Colorado River Valley Population of Greater Sandhill Cranes

The LCRVP is the smallest of the migratory populations of sandhill cranes in North America. The range of this population is believed to overlap ranges with the Rocky Mountain and Central Valley populations. Historically, winter counts of the LCRVP were not well-coordinated or conducted using a consistent methodology. However, efforts have been made to standardize areas surveyed and the timing of the survey to obtain more accurate counts and increased ability to determine trends in population abundance. Beginning in 1998, a coordinated winter aerial cruise survey with a fixed-wing aircraft has been conducted at the four major wintering areas: Cibola NWR, the Colorado River Indian Tribes wetland areas, Sonny Bono Salton Sea NWR, and the Gila River. Collectively, these counts are believed to contain in excess of 90% of the total number of cranes in this population. The counts are not corrected for cranes present but not seen by aerial crews, and therefore have unknown bias and precision. The survey resulted in 2,922 birds in 2019, a 22% increase from the previous year's count (Table 11, Fig. 21). The current 3-year average for the winter count is 2,678 cranes.

The LCRVP was not hunted after the signing of the Migratory Bird Treaty Act in 1918. In 2007, the Service completed an Environmental Assessment entitled "Proposed hunting regulations for the Lower Colorado River Valley Population of Greater Sandhill Cranes in the Pacific Flyway" (U.S.D.I. 2007). In 2008, the Service determined that a small allowable harvest (about 30) could be allowed on this population in years when the 3-year average of winter counts exceeded 2,500. The hunting season is guided by a cooperative management plan (Pacific Flyway Council 1995) which includes methodology for determining allowable harvests and allocation of the harvest. Once a hunting season is initiated, this season would be experimental for 3 years. After the 3 years, the season would be reviewed and revised if necessary.

A limited youth hunting season for this population was conducted during 2010 in Arizona, the only state that has hunted these cranes. No LCRVP cranes were harvested. The Pacific Flyway currently has no plans to conduct hunts for LCRVP cranes in the near future.

## Eastern Population of Greater Sandhill Cranes

In 1979, the U.S. Fish and Wildlife Service initiated a coordinated fall index survey of historic EP migratory staging areas in the Mississippi and Atlantic Flyways. This survey is conducted annually in late October by volunteers and agency personnel who count the number of cranes at staging areas throughout the EP range (S. Kelly, U.S. Fish and Wildlife Service, personal communication). Overall, the survey documented a long-term increasing trend in EP cranes with an average growth rate in the population of 3.9% per year (1979-2009) (Amundson and Johnson 2010). A more recent analysis indicates the growth rate has increased to 4.4% per year (U.S. Fish and Wildlife Service, unpublished data). The most recent fall count from 2018 was 97,751, which was 37% higher than the 2017 index of 71,401. The 3-year average is 88,185 (Table 12, Figure 22). This index is not a statistically designed population estimate; however, the index does reasonably represent a population estimate for EP cranes.

In 2010, the Mississippi and Atlantic Flyway Councils endorsed a management plan for EP cranes (Ad Hoc Eastern Population Sandhill Crane Committee 2010). One of the plan's provisions included guidelines for potential harvest of this population when the 3-year average of the fall survey is above 30,000 cranes. Kentucky and Tennessee initiated experimental hunting seasons in 2011 and 2013, respectively; the season in Kentucky became operational in 2015 and that for Tennessee in 2017. Seasons are allowed between September 1 and January

31 and have a maximum length of 60 days. Actual season dates have been from early December to late January in Kentucky and late November to late January in Tennessee (Table 13). According to the hunt plan, each state is allowed to issue a number of tags to hunters based on each state's five-year average peak crane abundance. Each tag allows a hunter to harvest one crane. Hunters in both states are required to complete mandatory crane identification training, tag and report harvested birds, and complete a post-season survey. In Kentucky, 534 tags were issued and hunters harvested 50 cranes during the inaugural season in 2011-12 (Table 14). In the 2018-19 season, 1,432 tags were issued to hunters, who harvested 60 cranes (J. Brunjes, Kentucky Department of Fish and Wildlife Resources, personal communication). Harvests in Tennessee have increased from 350 cranes during their initial season to 555 birds in 2018-19 (J. Feddersen, Tennessee Wildlife Resources Agency, personal communication) (Table 14).

## Priority Research Efforts and Needs for Management of Sandhill Cranes

1. On April 7-9, 2009, a workshop was conducted to discuss the status of North American sandhill cranes and to update research and management priorities. A published document providing outcomes and priority information needs from that first workshop (Case and Sanders 2009) is available at: <https://www.fws.gov/birds/surveys-and-data/webless-migratory-game-birds/sandhill-cranes.php>.

Many of those initial priority information needs have been, or are being addressed by the research and management community. Therefore, a second workshop was convened during April 14-15, 2014 in Lafayette, Louisiana. The purpose of the workshop was to review progress to date on the original priorities, and to develop a revised list of priorities based on that information. Workshop participants finalized an updated priority needs document (Collins et al. 2016a) with the following priorities:

Priority 1. Assessing Finer Scale Management of the Mid-Continent Population- Over the last decade, U.S. Geological Survey (USGS) researchers and partners have gathered much information about the MCP, specifically data regarding migration distribution and chronology, delineation of breeding affiliations, and potential harvest pressure on various segments of the MCP. Most of this research has been published (Krapu et al. 2011, 2014). Results indicate that four, largely geographically distinct, breeding affiliations can be identified that have different migration patterns and those groups may differ in their exposure to hunting pressure from east to west. Although research has not been completed to determine whether vital rates used in management (i.e., survival, recruitment) differ among breeding affiliations, data are sufficient to warrant examination as to whether management of the MCP should be targeted toward finer scales of the population. Future work should conduct an assessment of differences in vital rates among the breeding affiliations, and if such differences exist, determine whether managers can derive estimates of those parameters through operational monitoring programs to tailor management to smaller segments of the overall population.

Priority 2. Assessing Effects of Habitat Changes on the Rocky Mountain Population of Sandhill Cranes- Identification of the ecological stressors affecting cranes is essential to informing meaningful conservation for the RMP across its entire range (i.e., breeding, staging, and wintering). For example, their longevity, delayed maturation, and low recruitment may be masking habitat impacts already occurring, further

heightening the need to understand impacts of range-wide habitat changes to RMP cranes. Overcoming this information gap will better inform harvest management of the RMP, and provide land managers with decision-support tools to strategically focus conservation resources in areas of highest biological benefit.

Priority 3. Improving the monitoring of Eastern Population Greater Sandhill Cranes-The Eastern Population (EP) of greater sandhill cranes has expanded in both population size and geographic range in the last several decades (Amundson and Johnson 2010). Two states (Tennessee and Kentucky) within the Mississippi Flyway have implemented hunting seasons for EP cranes and other states are likely to explore opportunities in the future. In response to the first priorities document, Amundson and Johnson (2010) completed a critical review of existing fall survey data, which is currently used to formulate harvest-management recommendations. They also assessed other data sources, including the North American Breeding Bird Survey (BBS) and the Christmas Bird Count (CBC), for their adequacy of indexing population abundance. Their analyses indicated that the fall survey tracks abundance well, but not the geographic expansion of the population. The fall survey traditionally occurs during the last week of October under the assumption that the majority of EP cranes that breed in Canada have migrated to traditional staging areas in the U.S. and are available to be counted. Recent satellite telemetry studies (Fronczak 2014, Hanna et al. 2014, and D. Sherman, Ohio DNR, unpublished data) have identified that cranes breeding in Canada are in the U.S. during the current timing of the fall survey; however, between 20%-30% of marked EP cranes that summer in Wisconsin and Michigan are not present on staging areas during the current survey period and therefore are not available to be counted during the survey. A better understanding of the abundance and migration of birds in these areas is needed to complement the current information of EP distribution and migration chronology and further evaluate the adequacy of the fall survey for assessing population status.

Priority 4. Improving Population Abundance Estimates for the Mid-Continent Population-The current survey used to estimate abundance of the MCP has been in place since 1982, and it was believed the survey would account for >90% of the total MCP. A review of the abundance estimates indicated that (1) although historically the data indicate that the 90% threshold has been met in the majority of years, in recent years the threshold has not been met as frequently, and (2) the year-to-year variation in point estimates of crane abundance are biologically improbable given information on recruitment and survival, suggesting a systemic problem with the survey methodology. The first issue was identified in the 2009 priority information needs document. As a result, information was analyzed to assess the appropriateness of the timing of the annual survey. Results indicated that in 4 of the 7 years examined <90% of the marked cranes were in the CPRV at the time of the survey. Although recent work suggests the estimates derived are the best possible using the current methods, year-to-year variation in those counts are biologically untenable (Pearse et al. 2015). Given the changing landscape (e.g., timing of spring phenology, reduction in food availability) that could affect timing of migration and distribution of birds in the surveyed area, managers need to know whether the current monitoring scheme and/or fixed timing of the survey is still sufficient, or if alternative methods would be more appropriate.

2. Monographs on the geographic distribution and spring migration ecology of Mid-Continent Population sandhill cranes were published in 2011 and 2014 by Gary Krapu, Dave Brandt, Ken Jones, Doug Johnson, Paul Kinzel, and Aaron Pearse (Wildlife Monographs 175, 189). The results provide information from many years of satellite telemetry work which followed the cranes throughout their annual cycle, and have important implications for management of the MCP in the future.
3. The agricultural landscape on which sandhill cranes depend for a portion of their annual cycle has undergone dramatic changes in recent years. Published research indicates that the percentage of cropland in the CPRV that is being planted to soybeans, which are not valuable nutritionally for cranes, is increasing whereas the percentage planted to corn is decreasing (Pearse et al. 2010). In years when availability of corn is reduced, some cranes may not be able to increase lipid reserves as much as they did historically, due not only to increased crane numbers but also increased waterfowl abundance, particularly snow geese. If corn acreage and availability decline further, major changes could occur in the abundance or condition of cranes using the area. Changes in agricultural practices in other areas of the country (e.g., San Luis Valley of Colorado) also may be impacting other populations of cranes.
4. Work is being conducted on the annual distribution of sandhill crane populations in the west, particularly those of the LCRVP, the RMP, and the Central Valley Population (e.g., Collins et al. 2016b, Grisham et al. 2018). Researchers have used satellite telemetry to better understand movements and ranges of birds within these populations, and results suggest more overlap in ranges occurs than was previously thought. Additional work would assist managers in accurately delineating population boundaries, which could enhance management of the individual populations.
5. Current methods for estimating sandhill crane abundance involve diurnal surveys in fixed-winged aircraft with a pilot/observer and  $\geq 1$  other observer. During the day, sandhill cranes are widely dispersed over the landscape in feeding and loafing flocks, so a large amount of area must be surveyed to ensure a majority of cranes are counted to generate reasonably accurate estimates. In the mid-2000s, researchers from the U.S. Geological Survey attempted to estimate the number of MCP sandhill cranes roosting on portions of the CPRV at night (Kinzel et al. 2006), when birds are concentrated on stretches of the river. Although never implemented operationally due to cost and some logistical issues, such an approach may be more efficient than the current method of estimating sandhill cranes during the day. Researchers and biologists with the U.S. Geological Survey and the U.S. Fish and Wildlife Service Division of Migratory Bird Management are exploring the efficacy of nighttime surveys using the latest Unmanned Aerial Systems (i.e., drone) and camera technologies.

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Table 1. Annual spring abundance indices for the Mid-Continent Population of sandhill cranes.

YR	CENTRAL PLATTE RIVER VALLEY, NE			OTHER							ALL AREAS		
	OCULAR CRUISE TRANSECT	OCULAR TRANSECT	PHOTO CORRECTED OCULAR TRANSECT	OTHER							OCULAR CRUISE TRANSECT	OCULAR TRANSECT	PHOTO CORRECTED OCULAR TRANSECT
			ANNUAL	3-YR AVG	NE	KS	TX	CO <sup>1</sup>	OK <sup>1,2</sup>	NM <sup>1</sup>			WY <sup>2</sup>
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	7,100	2,000	7,800	2,800	0		100	367,796	437,063	
1983		306,316	343,378	4,100	200	7,000	0	200		tr	317,816	354,878	
1984		222,710	261,802	340,814	18,100	900	800	0	1,100	tr	243,610	282,702	358,214
1985		378,127	514,763	373,314	11,500	3,000	1,200				393,827	530,463	389,348
1986		317,025	353,040	376,535	1,000	200	2,100				320,325	356,340	389,835
1987		383,581	416,058	427,954	0	tr	400				383,981	416,458	434,420
1988		386,853	463,457	410,852	0	0	7,700				394,553	471,157	414,652
1989		391,353	391,995	423,837	100	1,000	800				393,253	393,895	427,170
1990		385,950	412,154	422,535	11,000	5,200	10,300				412,450	438,654	434,569
1991		297,831	340,645	381,598	100	800	200				298,931	341,745	391,431
1992		257,709	406,457	386,419	12,200	300	1,100				271,309	420,057	400,152
1993		253,799	378,883	375,328	16,800	37,750	13,500				321,849	446,933	402,912
1994		395,543	477,215	420,852	14,600	0	0	2,400			410,143	491,815	452,935
1995		273,376	326,181	394,093	30,400	0	0	6,700			303,776	356,581	431,776
1996		318,514	519,984	441,127	7,600	0	0	3,900			326,114	527,584	458,660
1997		350,932	534,630	460,265	16,200	100	0				367,232	550,930	478,365
1998		337,203	530,848	528,487	13,600	100	0				350,903	544,548	541,021
1999		219,794	284,858	450,112	3,500	100,000	0				323,294	388,358	494,612
2000		484,585	490,118	435,275	16,900	26,100	500				528,085	533,618	488,841
2001		387,336	413,498	396,158	10,500	42,300	3,500				443,636	469,798	463,925
2002		309,029	315,044	406,220	17,100	15,100	1,200	5,800			342,429	348,444	450,620
2003		300,918	348,023	358,855	24,800	4,100	3,800				333,618	380,723	399,655
2004		365,370	426,534	363,200	17,700	1,200	2,200	100			386,470	447,634	392,267
2005		412,285	491,915	422,157	27,100	2,900	8,700	2,600			450,985	530,615	452,991
2006		178,564	216,810	378,420	70,000	2,100	5,500				256,164	294,410	424,220
2007		307,094	384,118	364,281	20,400	3,600	5,900				336,994	414,018	413,014
2008		474,051	545,884	382,271	24,500	1,100	0				499,651	571,484	426,637
2009		457,436	565,257	498,420	29,900	tr	10,800				498,136	605,957	530,486
2010		455,104	691,534	600,892	17,600	1,300	28,000				502,004	738,434	638,625
2011		347,501	482,797	579,863	18,800	3,500	14,300	4,700			384,101	519,397	621,263
2012		253,783	339,642	504,658	12,900	tr	4,200				270,883	356,742	538,191
2013		745,854	867,061	563,167	16,080	279	9,740	1,800			771,953	893,160	589,766
2014		402,228	617,903	608,202	24,390	5,996	7,534	239			440,148	655,823	635,242
2015		326,053	386,471	623,812	24,545	4,479	37,121	2,195			392,198	452,616	667,200
2016		272,250	405,716	470,030	11,218	261	16,500	175			300,229	433,695	514,045
2017		436,671	568,369	453,519	18,674	180	9,193	16			464,718	596,416	494,242
2018 <sup>2</sup>		516,397	1,005,612	659,899	12,137	1,058	23,906	932		3,475	557,905	1,047,120	692,410
2019 <sup>2</sup>		633,839	945,996	839,992	16,818	2,423	39,460	777		4,140	697,457	1,009,614	884,383

<sup>1</sup> CO, OK, and NM were eliminated from the Official Survey Area in 1985 by the CF CMU.

<sup>2</sup> The 2018 revision to the Management Plan added OK and WY to counts for determination of the percentage of cranes in the Central Platte River Valley.

Table 2. Federal Mid-Continent sandhill crane permits issued in the Central Flyway and Minnesota.

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 <sup>2</sup>	46	46,845	
1998	4,937 <sup>2</sup>	1,088	270	449	6,082	1,385	951	32,523 <sup>2</sup>	49	47,734	
1999	4,847 <sup>2</sup>	1,235	279	516	6,050	1,438	810	33,380 <sup>2</sup>	52	48,607	
2000	5,169 <sup>2</sup>	1,084	283	493	7,451	1,333	721	44,719 <sup>2</sup>	58	61,311	
2001	5,869 <sup>2</sup>	1,374	253	509	8,078	1,315	680	49,410 <sup>2</sup>	72	67,560	
2002	5,644 <sup>2</sup>	1,279	303	496	8,245 <sup>3</sup>	1,186	619	37,558 <sup>2</sup>	54	55,384	
2003 <sup>1</sup>	5,854 <sup>2</sup>	1,206	273	471	6,030 <sup>3</sup>	1,000	563	43,199 <sup>2</sup>	50	58,646	
2004 <sup>1</sup>	5,784 <sup>2</sup>	1,180 <sup>3</sup>	308	548	5,788 <sup>3</sup>	780 <sup>3</sup>	307	52,161 <sup>2</sup>	61	66,917	
2005 <sup>1</sup>	5,766 <sup>2</sup>	805 <sup>3</sup>	281	494	7,441 <sup>3</sup>	698 <sup>3</sup>	490	51,511 <sup>2</sup>	68	67,554	
2006 <sup>1</sup>	4,792 <sup>2</sup>	826 <sup>3</sup>	265	512 <sup>4</sup>	7,410 <sup>3</sup>	615 <sup>3</sup>	445 <sup>5</sup>	70,968 <sup>2</sup>	78	85,911	
2007 <sup>1</sup>	4,931 <sup>2</sup>	598 <sup>3</sup>	238	480 <sup>4</sup>	7,442 <sup>3</sup>	731 <sup>3</sup>	390 <sup>5</sup>	101,382 <sup>2</sup>	58	116,250	
2008 <sup>1</sup>	5,772 <sup>2</sup>	655 <sup>3</sup>	272	677 <sup>4</sup>	6,501 <sup>3</sup>	736 <sup>3</sup>	398 <sup>5</sup>	122,553 <sup>2</sup>	73	137,637	
2009 <sup>1</sup>	4,038 <sup>2</sup>	540 <sup>3</sup>	139	862 <sup>4</sup>	7,774 <sup>3</sup>	1,029 <sup>3</sup>	693 <sup>5</sup>	11,332 <sup>5</sup>	62	26,469	
2010 <sup>1</sup>	4,280 <sup>2</sup>	508 <sup>3</sup>	283	701 <sup>4</sup>	8,375 <sup>3</sup>	1,055 <sup>3</sup>	410 <sup>5</sup>	12,560 <sup>5</sup>	86	28,258	1,954
2011 <sup>1</sup>	783 <sup>2</sup>	801 <sup>3</sup>	311	575 <sup>4</sup>	8,024 <sup>3</sup>	1,104 <sup>3</sup>	356 <sup>5</sup>	13,905 <sup>5</sup>	86	25,945	1,342
2012 <sup>1</sup>	801 <sup>2</sup>	571 <sup>3</sup>	186	859 <sup>4</sup>	8,519 <sup>3</sup>	451 <sup>3</sup>	343 <sup>5</sup>	14,083 <sup>5</sup>	102	25,915	1,032
2013 <sup>1</sup>	856 <sup>2</sup>	735 <sup>3</sup>	288	404 <sup>4</sup>	9,085 <sup>3</sup>	2,278 <sup>3</sup>	421 <sup>5</sup>	18,369 <sup>5</sup>	106	32,542	1,086
2014 <sup>1</sup>	848 <sup>2</sup>	787 <sup>3</sup>	356	368 <sup>4</sup>	4,692 <sup>3</sup>	660 <sup>3</sup>	390 <sup>5</sup>	20,105 <sup>5</sup>	433	28,639	1,216
2015 <sup>1</sup>	787 <sup>2</sup>	1,040 <sup>3</sup>	404	365 <sup>4</sup>	4,543 <sup>3</sup>	510 <sup>3</sup>	---	22,033 <sup>5</sup>	454	30,136	1,199
2016 <sup>1</sup>	841 <sup>2</sup>	1,055 <sup>3</sup>	376	416 <sup>4</sup>	3,956 <sup>3</sup>	559 <sup>3</sup>	171 <sup>5</sup>	23,962 <sup>5</sup>	569	31,905	1,139
2017 <sup>1</sup>	913 <sup>2</sup>	1,075 <sup>3</sup>	604	534 <sup>4</sup>	4,006 <sup>3</sup>	714 <sup>3</sup>	224 <sup>5</sup>	26,312 <sup>5</sup>	646	35,028	1,125
2018 <sup>1</sup>	954 <sup>2</sup>	2,678 <sup>3</sup>	676	2,413 <sup>4</sup>	4,102 <sup>3</sup>	642 <sup>3</sup>	237 <sup>5</sup>	29,668 <sup>5</sup>	392	41,762	1,091
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	28,100	
2000-09	5,362	955	262	554	7,216	942	531	58,479	63	74,364	
2010-2018	1,229	1,028	387	737	6,145	886	319	20,111	319	31,126	1,243
1975-2018	1,946	954	252	700	6,205	1,008	481	23,550	103	34,798	

<sup>1</sup> Preliminary

<sup>2</sup> Harvest Information Program (HIP) or a point-of-sale electronic record (without cost) used to identify crane hunters in lieu of a special sandhill crane hunting permit

<sup>3</sup> States began charging a fee for crane hunting permits which reduces the number of permits issued to hunters that only occasionally come into contact with sandhill cranes.

<sup>4</sup> NM uses a combination of electronic and paper permits.

<sup>5</sup> SD uses a special question in their HIP questionnaire to identify sandhill crane hunters; TX hunters can only obtain crane permits in selected locations.

<sup>6</sup> All hunters put in stratum "did not hunt" or "no" in state HIP sample frame, so no estimate is available.

**Table 3. Estimated active Mid-Continent sandhill crane hunters<sup>1</sup> in the Central Flyway and Minnesota.**

YR	CO	KS	MT	NM	ND	OK	SD	TX	WY	CF 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 <sup>2</sup>	236	495	60	244	2,271	64	114	4,821	10	8,315	
2004 <sup>2</sup>	315	539	93	252	2,491	265	79	5,121	16	9,171	
2005 <sup>2</sup>	280	274	90	233	3,370	259	165	5,383	24	10,078	
2006 <sup>2</sup>	144	445	71	245	3,272	243	144	5,531	25	10,120	
2007 <sup>2</sup>	158	255	82	241	3,145	166	57	5,685	19	9,808	
2008 <sup>2</sup>	191	283	84	239	2,815	255	64	6,338	24	10,293	
2009 <sup>2</sup>	159	213	50	286	3,546	371	63	3,179	67	7,934	
2010 <sup>2</sup>	302	182	93	192	3,474	332	52	4,187	29	8,843	964
2011 <sup>2</sup>	138	449	95	206	3,733	418	44	2,712	41	7,836	643
2012 <sup>2</sup>	139	214	59	270	3,332	160	54	2,972	39	7,239	410
2013 <sup>2</sup>	118	235	94	276	3,326	638	91	5,473	35	10,286	485
2014 <sup>2</sup>	89	151	88	252	1,743	231	56	5,145	70	7,825	401
2015 <sup>2</sup>	126	334	115	263	1,430	158	---	3,241	78	5,745	424
2016 <sup>2</sup>	144	332	113	310	1,504	219	39	6,746	96	9,503	471
2017 <sup>2</sup>	221	710	98	360	1,562	246	71	7,066	305	10,639	397
2018 <sup>2</sup>	178	1004	175	416	1,626	258	73	8,807	94	12,631	383
<b>AVERAGES:</b>											
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	
2010-2018	162	401	103	283	2,414	296	60	5,150	87	8,950	509
1975-2018	165	402	72	312	2,660	312	123	3,726	29	7,634	

<sup>1</sup> Those permittees reporting hunting cranes 1 or more times

<sup>2</sup> Preliminary

<sup>3</sup> All hunters put in stratum "did not hunt" or "no" in state HIP sample frame, so no estimate is available.



Table 5. Estimated retrieved harvests of Mid-Continent sandhill cranes in the U.S.

YR	CO	KS	MT	NM	ND	OK	SD	TX	WY	CENTRAL	OTHER SURVEY AREAS				U.S.		
										FLYWAY	AZ <sup>4</sup>	NM <sup>4</sup>	AK <sup>2,3</sup>	MN <sup>5</sup>	TOTAL	TOTAL	
1975	91		16	911	2,122	142	86	6,123	6	9,497				1,094	1,094	10,591	
1976	106		29	858	52	200	12	6,122	14	7,393				637	637	8,030	
1977	39		18	1,456	4,078	410	47	6,094	9	12,151				471	471	12,622	
1978	106		36	1,089	2,777	389	19	5,720	10	10,146				239	239	10,385	
1979	129		14	1,170	2,733	397	19	5,917	0	10,379				517	517	10,896	
1980	68		16	1,019	2,245	363	130	6,305	6	10,152				809	809	10,961	
1981	92		11	907	2,395	397	78	6,245	9	10,134	20			383	403	10,537	
1982	49		21	335	2,469	535	212	4,295	0	7,916	62			1,160	1,222	9,138	
1983	70		28	354	6,471	373	177	5,471	15	12,959	17			1,540	1,557	14,516	
1984	85		15	414	4,367	433	139	5,811	7	11,271	23			1,986	2,009	13,280	
1985	82		7	334	4,650	416	101	7,184	2	12,776	48			1,197	1,245	14,021	
1986	33		1	250	6,563	392	99	5,149	0	12,487	108	184		539	831	13,318	
1987	86		15	159	5,334	957	99	6,117	3	12,770	127	318		836	1,281	14,051	
1988	68		18	372	3,815	1,061	100	7,330	8	12,772	172	127	1,241		1,540	14,312	
1989	25		33	319	4,656	1,003	194	7,400	9	13,639	126	138	545		809	14,448	
1990	87		44	377	6,804	698	165	9,865	1	18,041	114	259	918		1,291	19,332	
1991	224		31	593	4,580	604	128	6,916	3	13,079	172	235	677		1,084	14,163	
1992	84		103	505	4,654	478	141	6,455	13	12,433	139	54	640		833	13,266	
1993	112	602	95	506	6,985	826	110	8,769	0	18,005	113	178	201		492	18,497	
1994	143	767	56	357	6,235	1,167	239	7,233	4	16,201	86	153	648		887	17,088	
1995	208	990	156	673	7,017	1,091	170	10,322	1	20,628	124	111	812		1,047	21,675	
1996	91	933	58	332	6,639	1,066	166	7,816	10	17,111	114	78	1,205		1,397	18,508	
1997	168	1,167	45	248	6,545	600	189	10,800	4	19,766	171	45	870		1,086	20,852	
1998	64	1,362	17	258	7,967	645	454	9,054	10	19,831	114	55	1,042		1,211	21,042	
1999	56	1,275	29	321	5,748	879	184	8,469	8	16,969	92	101	NA <sup>*</sup>		193	17,162	
2000	363	590	15	311	5,081	552	374	8,208	10	15,504	166	100	985		1,251	16,755	
2001	257	1,033	43	297	5,173	713	478	6,999	7	15,000	154	106	936		1,196	16,196	
2002	294	1,067	23	342	2,852	490	160	7,837	22	13,087	197	92	844		1,133	14,220	
2003 <sup>1</sup>	230	942	49	617	4,564	200	166	11,560	7	18,335	155	162	331		648	18,983	
2004 <sup>1</sup>	92	856	54	350	3,967	441	67	8,715	4	14,546	192	167	435		794	15,340	
2005 <sup>1</sup>	265	471	65	578	3,721	511	190	12,446	16	18,263	227	175	388		790	19,053	
2006 <sup>1</sup>	96	1,341	12	682	3,906	538	202	10,834	20	17,631	201	245	314		760	18,391	
2007 <sup>1</sup>	149	516	51	427	4,501	272	163	12,511	20	18,610	268	331	596		1,195	19,805	
2008 <sup>1</sup>	32	453	73	483	4,179	493	83	17,169	24	22,989	138	329	1,249		1,716	24,705	
2009 <sup>1</sup>	58	447	34	584	4,436	737	96	8,882	8	15,282	305	332	245		882	16,164	
2010 <sup>1</sup>	115	293	95	432	4,752	940	91	12,069	25	18,812	253	421	1,204	830	2,708	21,520	
2011 <sup>1</sup>	68	908	51	297	3,733	808	64	8,493	20	14,442	151	367	335	765	1,618	16,060	
2012 <sup>1</sup>	77	437	30	388	3,019	401	185	10,309	41	14,887	300	341	1,360	407	2,408	17,295	
2013 <sup>1</sup>	47	771	77	326	4,137	1,085	109	14,991	41	21,584	138	161	930	378	1,607	23,191	
2014 <sup>1</sup>	41	176	114	269	2,924	390	85	11,740	37	15,776	151	123	1,123	247	1,644	17,420	
2015 <sup>1</sup>	98	1,005	91	267	2,133	302	---	8,283	28	12,207	311	132	---	7	212	655	12,862
2016 <sup>1</sup>	102	873	111	660	2,507	538	183	18,196	83	23,253	292	404	1,036	287	2,019	25,272	
2017 <sup>1</sup>	280	1,440	85	641	3,466	559	165	19,559	263	26,458	435	399	793	196	1,823	28,281	
2018 <sup>1</sup>	102	2,479	73	701	3,424	718	119	22,526	33	30,175	587	284	705	129	1,705	31,880	
AVERAGES:																	
1975-79	94		23	1,097	2,352	308	37	5,995	8	9,913			592		592	10,505	
1980-89	66		17	446	4,297	593	133	6,131	6	11,688	78	192	1,024		1,171	12,858	
1990-99	124	1,014	63	417	6,317	805	195	8,570	5	17,206	124	127	779		952	18,159	
2000-09	184	772	42	467	4,238	495	198	10,516	14	16,925	200	204	632		1,037	17,961	
2010-2018	103	931	81	442	3,344	638	125	14,018	63	19,733	291	292	936	383	1,799	21,531	
1975-2018	117	892	47	517	4,327	596	150	9,280	20	15,576	173	203	810		1,153	16,729	
CURRENT YEAR PERCENT CHANGE FROM:																	
2017	-64%	72%	-14%	9%	-1%	28%	-28%	15%	-87%	14%	35%	-29%	-11%	-34%	-6%	13%	
1975-79	8%		223%	-36%	46%	133%	225%	276%	323%	204%			19%		188%	203%	
1980-89	55%		342%	57%	-20%	21%	-10%	267%	459%	158%	651%	48%	-31%		46%	148%	
1990-99	-18%	145%	15%	68%	-46%	-11%	-39%	163%	511%	75%	374%	124%	-10%		79%	76%	
2000-09	-44%	221%	74%	50%	-19%	45%	-40%	114%	139%	78%	193%	39%	11%		64%	77%	
2010-2018	-1%	166%	-10%	58%	2%	13%	-5%	61%	-48%	53%	102%	-3%	-25%	-66%	-5%	48%	
1975-2018	-13%	178%	56%	35%	-21%	21%	-21%	143%	69%	94%	240%	40%	-13%		48%	91%	

<sup>1</sup> Preliminary

<sup>2</sup> A proportion of the Alaskan harvest is composed of lesser sandhill cranes from the Pacific Coast Population

<sup>3</sup> Harvest data are from state harvest surveys for only the MCP portion of the state, except in 1977-81, 1986, 1991, and 1998-99 where federal MGS state totals are prorated by the long-term percent MC cranes; data from 2000 forward are MC portion from HIP.

<sup>4</sup> 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

<sup>5</sup> Minnesota initiated a hunt in the NW portion of state.

<sup>6</sup> All hunters put in stratum "did not hunt" or "no" in state HIP sample frame, so no estimate is available.

<sup>7</sup> HIP sample frame from state was incomplete.

\* No estimate is available.

**Table 6. Estimated retrieved harvests of Mid-Continent sandhill cranes in Canada.**

<b>YEAR</b>	<b>MB</b>	<b>SK</b>	<b>TOTAL</b>
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	162	5,744	5,906
1976	209	1,427	1,636
1977	367	N/A	367
1978	877	N/A	877
1979	978	2,821	3,799
1980	891	4,698	5,589
1981	510	2,456	2,966
1982	797	2,037	2,834
1983	377	2,711	3,088
1984	661	3,042	3,703
1985	691	4,448	5,139
1986	1,662	4,452	6,114
1987	664	4,480	5,144
1988	1,958	4,990	6,948
1989	2,652	2,323	4,975
1990	1,023	3,812	4,835
1991	1,771	3,547	5,318
1992	1,221	4,718	5,939
1993	482	2,433	2,915
1994	544	3,286	3,830
1995	1,004	4,823	5,827
1996	1,351	2,961	4,312
1997	1,279	4,621	5,900
1998	889	8,637	9,526
1999	1,300	7,100	8,400
2000	805	8,645	9,450
2001	1,247	7,539	8,786
2002	1,282	6,665	7,947
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	9,862	11,502
2017	2,145	11,297	13,442
2018	3,335	9,671	13,006
<b>AVERAGES:</b>			
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
2010-2018	1,876	8,575	10,450
1971-2018	1,212	5,659	6,635
<b>CURRENT YEAR PERCENT CHANGE FROM:</b>			
2017	55%	-14%	-3%
1971-79	717%	171%	309%
1980-89	207%	171%	180%
1990-99	207%	111%	129%
2000-09	110%	26%	41%
2010-2018	78%	13%	24%
1971-2018	175%	71%	96%

**Table 7. Annual sport hunting mortality estimates for the Mid-Continent Population of sandhill cranes in North America.**

YR	SPORT HUNTING MORTALITY					Total
	Retrieved				Unretrieved No. Am. <sup>3</sup>	
	Central Flyway	Other Survey Total	Canada	Mexico <sup>2</sup>		
1975	9,497	1,094	5,906	1,650	3,615	21,762
1976	7,393	637	1,636	967	2,032	12,665
1977	12,151	471	367	1,299	2,440	16,728
1978	10,146	239	877	1,126	2,308	14,697
1979	10,379	517	3,799	1,470	2,807	18,972
1980	10,152	809	5,589	1,655	3,351	21,556
1981	10,134	403	2,966	1,350	2,724	17,577
1982	7,916	1,222	2,834	1,197	2,451	15,620
1983	12,959	1,557	3,088	1,760	3,501	22,865
1984	11,271	2,009	3,703	1,698	3,372	22,053
1985	12,776	1,245	5,139	1,916	3,520	24,596
1986	12,487	831	6,114	1,943	3,648	25,023
1987	12,770	1,281	5,144	1,920	3,379	24,493
1988	12,772	1,540	6,948	2,126	3,751	27,137
1989	13,639	809	4,975	1,942	3,626	24,992
1990	18,041	1,291	4,835	2,417	4,228	30,811
1991	13,079	1,084	5,318	1,948	3,438	24,867
1992	12,433	833	5,939	1,921	3,198	24,323
1993	18,005	492	2,915	2,141	3,362	26,915
1994	16,201	887	3,830	2,092	3,038	26,048
1995	20,628	1,047	5,827	2,750	4,161	34,413
1996	17,111	1,397	4,312	2,282	3,609	28,711
1997	19,766	1,086	5,900	2,675	4,211	33,638
1998	19,831	1,211	9,526	3,057	4,901	38,526
1999	16,969	193 <sup>4</sup>	8,400	2,556	3,947	32,065
2000	15,504	1,251	9,450	2,621	4,093	32,919
2001	15,000	1,196	8,786	2,498	4,013	31,493
2002	13,087	1,133	7,947	2,217	3,446	27,830
2003 <sup>1</sup>	18,335	648	9,585	2,857	4,246	35,671
2004 <sup>1</sup>	14,546	794	11,037	2,638	4,165	33,179
2005 <sup>1</sup>	18,263	790	9,876	2,893	4,512	36,334
2006 <sup>1</sup>	17,631	760	10,417	2,881	4,864	36,552
2007 <sup>1</sup>	18,610	1,195	11,786	3,159	4,904	39,654
2008 <sup>1</sup>	22,989	1,716	9,439	3,414	4,432	41,990
2009 <sup>1</sup>	15,282	882	4,165	2,033	3,100	25,462
2010 <sup>1</sup>	18,812	2,708	7,331	2,885	4,400	36,136
2011 <sup>1</sup>	14,442	1,618	10,431	2,649	4,006	33,146
2012 <sup>1</sup>	14,887	2,408	5,041	2,234	3,397	27,966
2013 <sup>1</sup>	21,584	1,607	9,883	3,307	4,188	40,570
2014 <sup>1</sup>	15,776	1,644	12,812	3,023	4,521	37,776
2015 <sup>1,5</sup>	12,207	655	10,604	2,347	3,652	29,465
2016 <sup>1</sup>	23,253	2,019	11,502	3,677	4,460	44,911
2017 <sup>1</sup>	26,458	1,823	13,442	4,172	5,533	51,429
2018 <sup>1</sup>	30,175	1,705	13,006	4,489	5,303	54,678

AVERAGES:						
1975-79	9,913	592	2,517	1,302	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
2010-2018	19,733	1,799	10,450	3,198	4,384	39,564
1975-2018	15,576	1,175	6,873	2,360	3,769	29,732

CURRENT YEAR PERCENT CHANGE FROM:						
2017	14%	-6%	-3%	8%	-4%	6%
1975-79	204%	188%	417%	245%	101%	222%
1980-89	158%	46%	180%	156%	59%	142%
1990-99	75%	65%	129%	88%	39%	82%
2000-09	78%	64%	41%	65%	27%	60%
2010-2018	53%	-5%	24%	40%	21%	38%
1975-2018	94%	45%	89%	90%	41%	84%

<sup>1</sup> Preliminary

08/06/19

<sup>2</sup> Unknown harvests (Mexico) were assumed to be 10% of harvests in the U.S. and Canada.

<sup>3</sup> 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.

<sup>4</sup> There is no estimate available for AK in that year.

<sup>5</sup> Estimates (except Canada) biased low because of HIP sampling issues in SD and AK that resulted in estimates of zero harvest for each.



**Table 8. Spring population indices for Rocky Mountain sandhill cranes, 1984-96.**

YR	SAN LUIS VALLEY, COLORADO				INDEX	SURVEY COND.
	RAW COUNT	ADJ. FOR EST. BIAS <sup>1</sup>	ADJ. FOR REM. LES. <sup>2</sup>	OTHER AREAS		
1984	10,962	14,488	13,562	550	14,112	POOR
1985	18,393	21,773	20,382	0	20,382	GOOD
1986	14,031	14,031	13,135	20	13,155	POOR
1987	13,561	15,661	14,660	0	14,660	POOR
1988	17,510	17,510	16,381	22	16,403	POOR
1989	17,302	18,389	17,004	0	17,004	GOOD
1990	20,851	24,593	21,221	275	21,496	GOOD
1991	19,990	18,405	16,045	175	16,220	GOOD
1992	23,516	23,516	19,999	9	20,008	GROUND
1993	17,576	17,576	16,478	1,260	17,738	POOR
1994	17,229	16,036	15,063	203	15,266	FAIR
1995	25,276	23,390	20,229	0	20,229	GOOD
1996	23,019	26,379	22,737	1,010	23,747	GOOD

<sup>1</sup> Raw estimate adjusted by photography for estimation bias.

<sup>2</sup> Population estimate adjusted to remove the number of lesser sandhill cranes (non-RMP cranes).

**Table 9. Fall pre-migration population indices for Rocky Mountain sandhill cranes.**

YR	UT	CO	ID	WY	MT	TOTAL	3-YR AVG
1987	1,578	1,443	10,686	2,327	1,447	17,481	
1992	2,810	3,181	5,801	2,248	5,264	19,304	
1995	1,528	2,284	6,864	1,671	3,681	16,028	
1996	1,849	1,255	8,334	2,526	2,974	16,938	
1997 <sup>1, 2</sup>	2,450	1,604	8,132	2,255	3,595	18,036	17,001
1998	2,185	1,273	8,067	3,162	3,415	18,102	17,692
1999	2,292	1,102	8,761	4,205	3,141	19,501	18,546
2000	2,416	749	9,337	3,890	3,598	19,990	19,198
2001	1,522	666	7,160	2,626	4,585	16,559	18,683
2002	1,869	1,355	7,698	3,038	4,843	18,803	18,451
2003	2,546	745	7,822	3,446	4,964	19,523	18,295
2004	2,239	1,410	7,152	3,072	4,637	18,510	18,945
2005	2,646	1,052	7,668	3,911	5,588	20,865	19,633
2006 <sup>3</sup>						NS	19,633
2007 <sup>4</sup>	2,401	1,743	8,262	3,907	6,509	22,822	20,732
2008 <sup>5</sup>	3,708	1,080	6,123	3,826	6,419	21,156	21,614
2009	2,283	1,162	6,934	3,613	6,329	20,321	21,433
2010	3,242	985	5,776	3,726	7,335	21,064	20,847
2011	1,498	1,347	5,029	2,978	6,642	17,494	19,626
2012	2,109	413	3,432	3,587	5,876	15,417	17,992
2013	2,732	1,594	5,228	3,588	7,218	20,360	17,757
2014	2,783	1,258	6,064	3,008	6,555	19,668	18,482
2015	3,698	1,089	6,454	3,596	9,493	24,330	21,453
2016 <sup>6</sup>	3,298	1,135	5,445	4,879	7,507	22,264	22,087
2017	2,994	1,658	4,066	3,725	7,149	19,592	22,062
2018	2,770	1,908	4,469	5,101	7,553	21,801	21,219

<sup>1</sup> Incomplete survey efforts in years prior might have resulted in lower estimates; the official count begins 08/06/19

<sup>2</sup> In October 1997, a special survey was also conducted in the SLV, Colorado and other areas, which resulted in a total of 27,090 Rocky Mountain and Mid-Continent cranes being counted.

<sup>3</sup> In 2006, the survey was not conducted due to mechanical issues with the survey plane. The 3-yr Avg for 2006 is calculated using 2003-05.

<sup>4</sup> The 3-yr average for 2007 was calculated using 2004, 2005, and 2007 because there was no survey in 2006.

<sup>5</sup> The 3-yr average for 2008 was calculated using 2005, 2007, and 2008 because there was no survey in 2006.

<sup>6</sup> Beginning 1n 2016 Wyoming added six new survey areas as allowed in the management plan.

**Table 10. Estimated retrieved harvests of the Rocky Mountain Population of sandhill cranes.**

<b>YR</b>	<b>UT</b>	<b>NM</b>	<b>AZ</b>	<b>WY</b>	<b>MT</b>	<b>ID</b>	<b>TOTAL</b>
1981			20				20
1982			9	143			152
1983			35	154			189
1984			33	101			134
1985			40	138			178
1986			23	195			218
1987			60	190			250
1988		310	40	128			478
1989	54	483	51	125			713
1990	35	79	9	58			181
1991	48	47	44	101			240
1992	0	147	39	168	42		396
1993	28	297	61	115	45		546
1994	34	416	27	150	40		667
1995	27	270	33	77	41		448
1996	32	236	27	84	49	20	448
1997	30	114	22	82	62	136	446
1998	34	180	37	93	59	135	538
1999	54	198	21	124	71	190	658 <sup>1</sup>
2000	69	257	37	163	91	193	810 <sup>2</sup>
2001	77	288	26	142	87	278	898
2002	60	164	42	132	51	194	643
2003	57	169	34	72	50	146	528
2004	53	189	35	124	51	142	594
2005	62	236	50	116	49	189	702
2006	87	327	10	194	54	235	907
2007	103	276	43	138	73	187	820
2008	101	379	24	162	85	185	936
2009	149	603	67	195	124	254	1,392
2010	190	547	56	182	108	253	1,336
2011 <sup>3</sup>	149	522	37	166	90	293	1,257
2012 <sup>3</sup>	91	417	85	134	129	275	1,131
2013 <sup>3</sup>	95	241	38	74	94	135	677
2014	73	183	20	94	121	134	625
2015	86	145	67	104	137	166	705
2016	72	453	74	158	140	258	1,155
2017	189	395	68	193	150	198	1,193
2018	203	623	102	189	154	253	1,524
<b>AVERAGES:</b>							
1981-89		397	35	147			259
1990-99	32	198	32	105	51	120	457
2000-09	82	289	37	144	72	200	823
2010-2018	128	392	61	144	125	218	1,067
1981-2018	78	296	41	134	83	193	651
<b>CURRENT YEAR PERCENT CHANGE FROM:</b>							
2017	7%	58%	50%	-2%	3%	28%	28%
1981-89		57%	195%	29%			488%
1990-99	530%	214%	219%	80%	201%	110%	234%
2000-09	148%	116%	177%	31%	115%	26%	85%
2010-2018	59%	59%	68%	31%	23%	16%	43%
1981-2018	160%	110%	151%	41%	85%	31%	134%

<sup>1</sup> RMP Sandhill cranes (40) were also taken as part of research project in the San Luis Valley, CO

<sup>2</sup> RMP Sandhill cranes (20) were also taken as part of research project in the San Luis Valley, CO

<sup>3</sup> Harvest includes crippling loss.

**Table 11. Winter counts of Lower Colorado River Valley Population of sandhill cranes in Arizona and California.**

YR	Cibola NWR	Colorado River Indian Tribe	Salton Sea NWR	Gila River	TOTAL	3-YR AVG
1998	775	596	351	178	1,900	
1999	1,200	511	325	163	2,199	
2000	820	1,259	235	252	2,566	2,222
2001	961	952	350	134	2,397	2,387
2002	1,003	168	417	52	1,640	2,201
2003	1,200	455	430	0	2,085	2,041
2004	1,341	354	521	312	2,528	2,084
2005	1,513	457	476	191	2,637	2,417
2006	1,141	673	493	360	2,667	2,611
2007	2,322	809	295	450	3,876	3,060
2008 <sup>1</sup>	115	NS	687	413	1,215	3,060
2009 <sup>2</sup>	289	1216	603	293	2,401	2,981
2010 <sup>3</sup>	266	729	904	365	2,264	2,847
2011	553	636	899	327	2,415	2,360
2012	1,097	474	924	151	2,646	2,442
2013	1,629	344	671	434	3,078	2,713
2014	1,981	591	641	140	3,353	3,026
2015	676	720	688	452	2,536	2,989
2016	631	631	862	292	2,416	2,768
2017	940	636	819	321	2,716	2,556
2018	1,076	330	775	215	2,396	2,509
2019	1,171	192	1062	497	2,922	2,678

NS = No survey was conducted.

08/06/19

<sup>1</sup> In 2008, the survey was not complete. The 3-YR average for that year was calculated using 2005-07.

<sup>2</sup> In 2009, the 3-YR average was calculated with 2006, 2007 and 2009 due to an incomplete survey in 2008.

<sup>3</sup> In 2010, the 3-YR average was calculated with 2007, 2009, and 2010 due to an incomplete survey in 2008.

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**Table 12. Fall abundance index for Eastern Population of sandhill cranes.**

<b>YR</b>	<b>TOTAL</b>	<b>3-YR AVG</b>
1979	14,385	
1980	15,808	
1981	11,943	14,045
1982	13,879	13,877
1983	14,898	13,573
1984	16,363	15,047
1985	16,170	15,810
1986	17,043	16,525
1987	22,342	18,518
1988	16,086	18,490
1989	22,785	20,404
1990	23,852	20,908
1991	26,156	24,264
1992	26,656	25,555
1993	26,187	26,333
1994	26,783	26,542
1995	33,774	28,915
1996	29,753	30,103
1997	29,448	30,992
1998	37,827	32,343
1999	33,583	33,619
2000	33,105	34,838
2001 <sup>1</sup>	NS	34,838
2002 <sup>2</sup>	31,575	32,754
2003 <sup>3</sup>	29,300	31,327
2004	28,947	29,941
2005	37,708	31,985
2006	37,529	34,728
2007	35,945	37,061
2008	44,110	39,195
2009	59,876	46,644
2010	49,666	51,217
2011	72,233	60,592
2012	87,796	69,898
2013	64,322	74,784
2014	83,479	78,532
2015	94,869	80,890
2016	95,403	91,250
2017	71,401	87,224
2018	97,751	88,185

NS = No survey conducted

08/06/19

<sup>1</sup> In 2001, the survey was not conducted. The 3-YR average for that year was calculated using data from 1998-2000.

<sup>2</sup> In 2002, the 3-YR average was calculated with 1999, 2000 and 2002 since the survey was not conducted in 2001.

<sup>3</sup> In 2003, the 3-YR average was calculated with 2000, 2002 and 2003 since the survey was not conducted in 2001.

**Table 13. Season dates (month/day) for the hunting of Eastern Population sandhill cranes.**

YR	KY	TN
2011	12/17-01/15	No Season
2012	12/15-01/13	No Season
2013	12/14-01/12	11/28-01/01
2014	12/13-01/11	11/22-11/23; 11/29-01/01
2015	12/12-01/10	11/28-11/29; 12/05-01/01
2016	12/17-01/15	12/03-01/12; 01-16-01/29
2017	12/16-01/14	12/02-01/28 <sup>1</sup>
2018	12/03-01/27	12/01-01/27 <sup>2</sup>

<sup>1</sup> In the Southeast Zone, the season was closed from 01/12-01/14.

<sup>2</sup> In the Southeast Zone, the season was closed from 01/18-01/20.

**Table 14. Estimated harvest and number of permits sold for Eastern Population sandhill cranes.**

YR	KY		TN		TOTAL	
	Harvest	Tags Issued <sup>1</sup>	Harvest	Tags Issued <sup>1</sup>	Harvest	Permits Issued
2011	50	534	No Season		50	534
2012	92	570	No Season		92	570
2013	87	570	350	1200	437	1770
2014	96	704	393	1200	489	1904
2015	75	694	161	1200	236	1894
2016	171	672	586	1200	757	1872
2017	119	660	830	2319	949	2979
2018	60	1432	555	2711	615	4143
<b>Average</b>	94	730	479	1638	453	1958

<sup>1</sup>Each tag allows a hunter to take one crane.

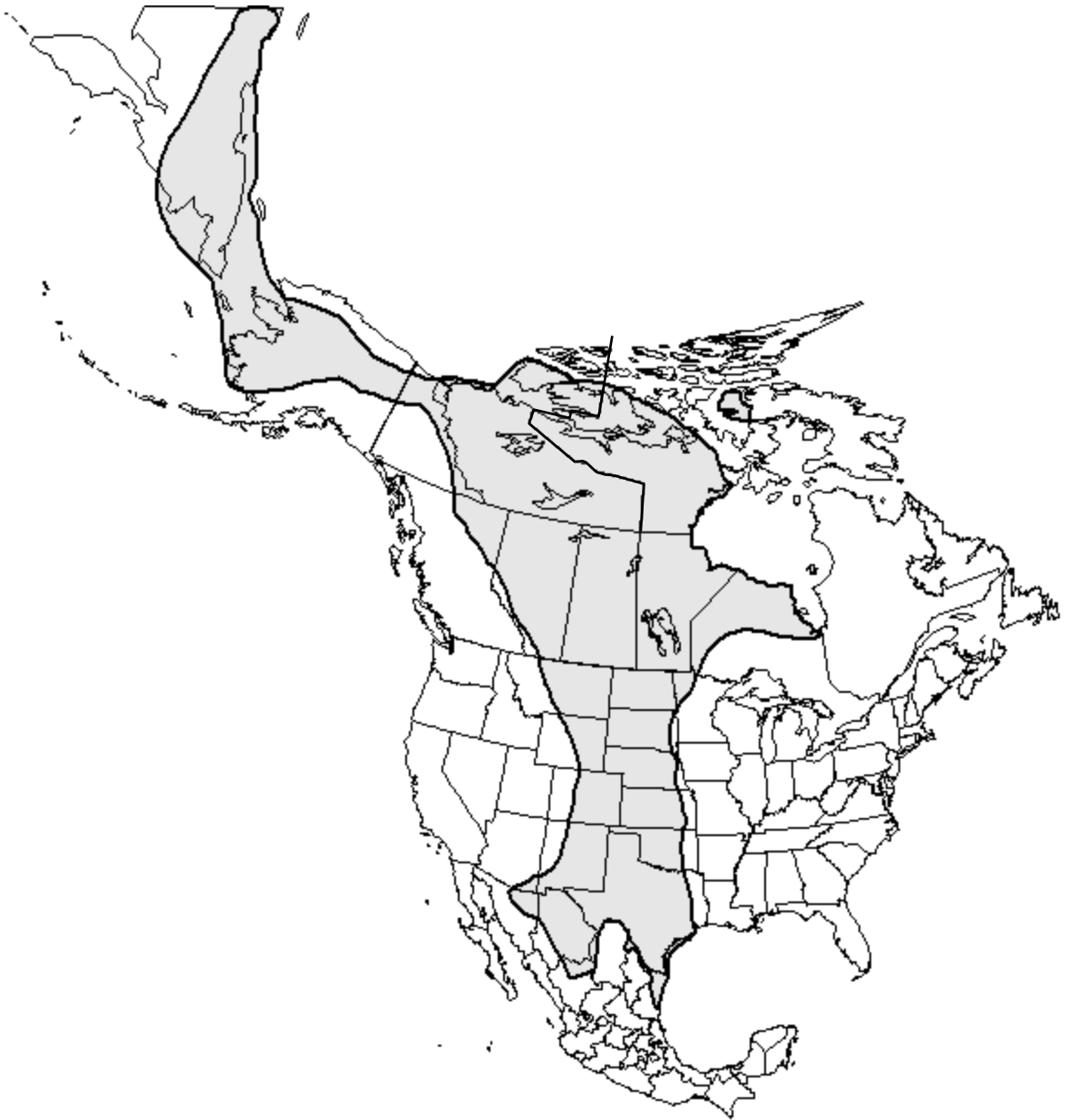


Figure 1. Primary wintering and breeding range and the approximate migration corridor of Mid-Century sandhill cranes (based on figures in Tacha et al. 1994, Krapu et al. 2011).



Figure 2. Approximate range of the Rocky Mountain Population of Greater Sandhill Cranes (Tacha et al. 1994, Drewien et al. 1996).

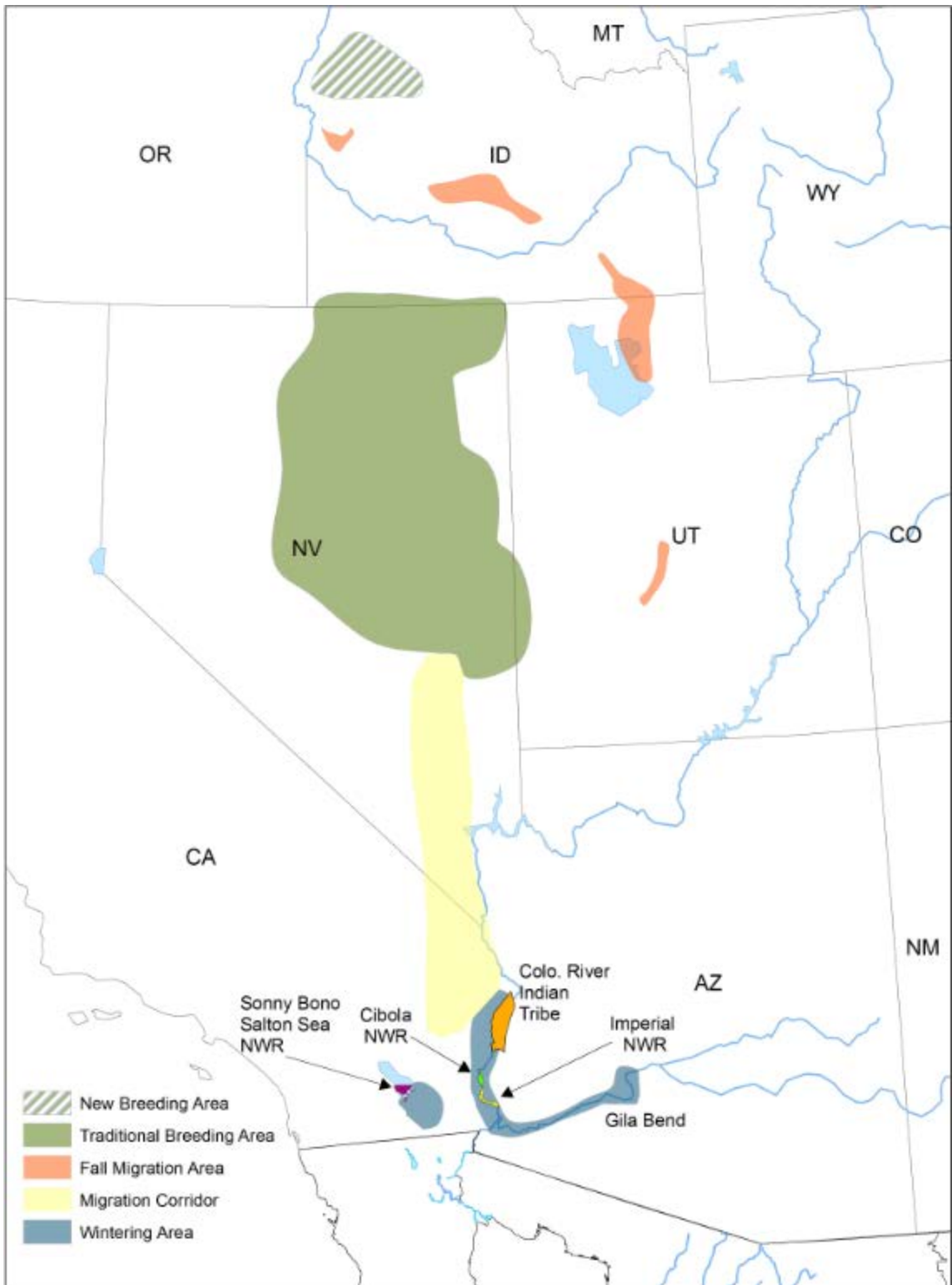


Figure 3. Approximate range of the Lower Colorado River Valley Population of Greater Sandhill Cranes (based on Pacific Flyway Council [1995] and recent satellite telemetry information [D. Collins and K. Kruse, U.S. Fish and Wildlife Service, unpublished data]).



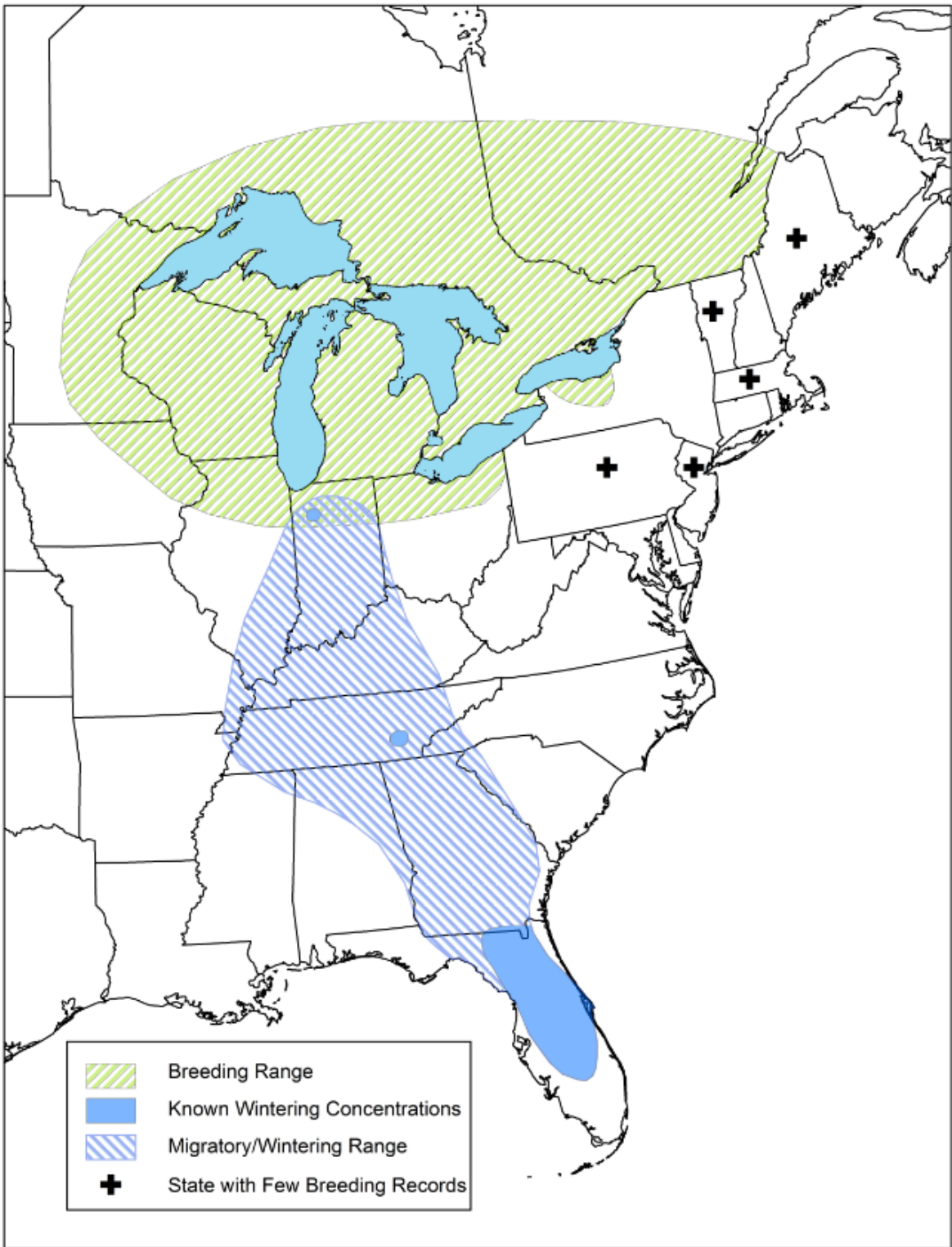


Figure 4. Approximate range of Eastern Population sandhill cranes based on various data sources including satellite telemetry data, breeding bird atlas records, and unpublished location information from knowledgeable individuals.

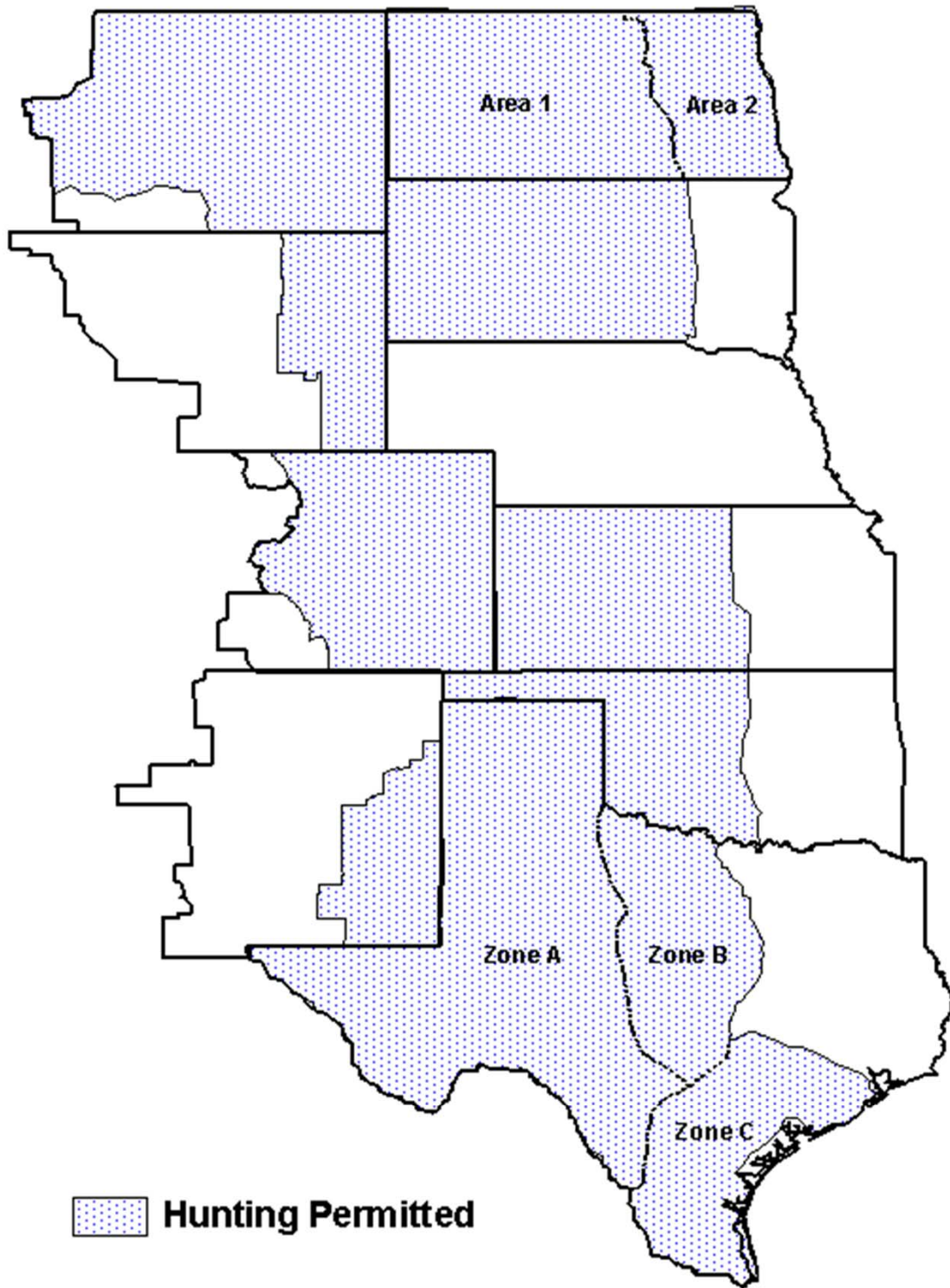


Figure 5. Areas open to the hunting of Mid-Continent sandhill cranes by Federal frameworks in the Central Flyway states, 2018-19.

Figure 6. Annual harvests of Mid-Continent sandhill cranes in Saskatchewan and North Dakota, 1980-2018.

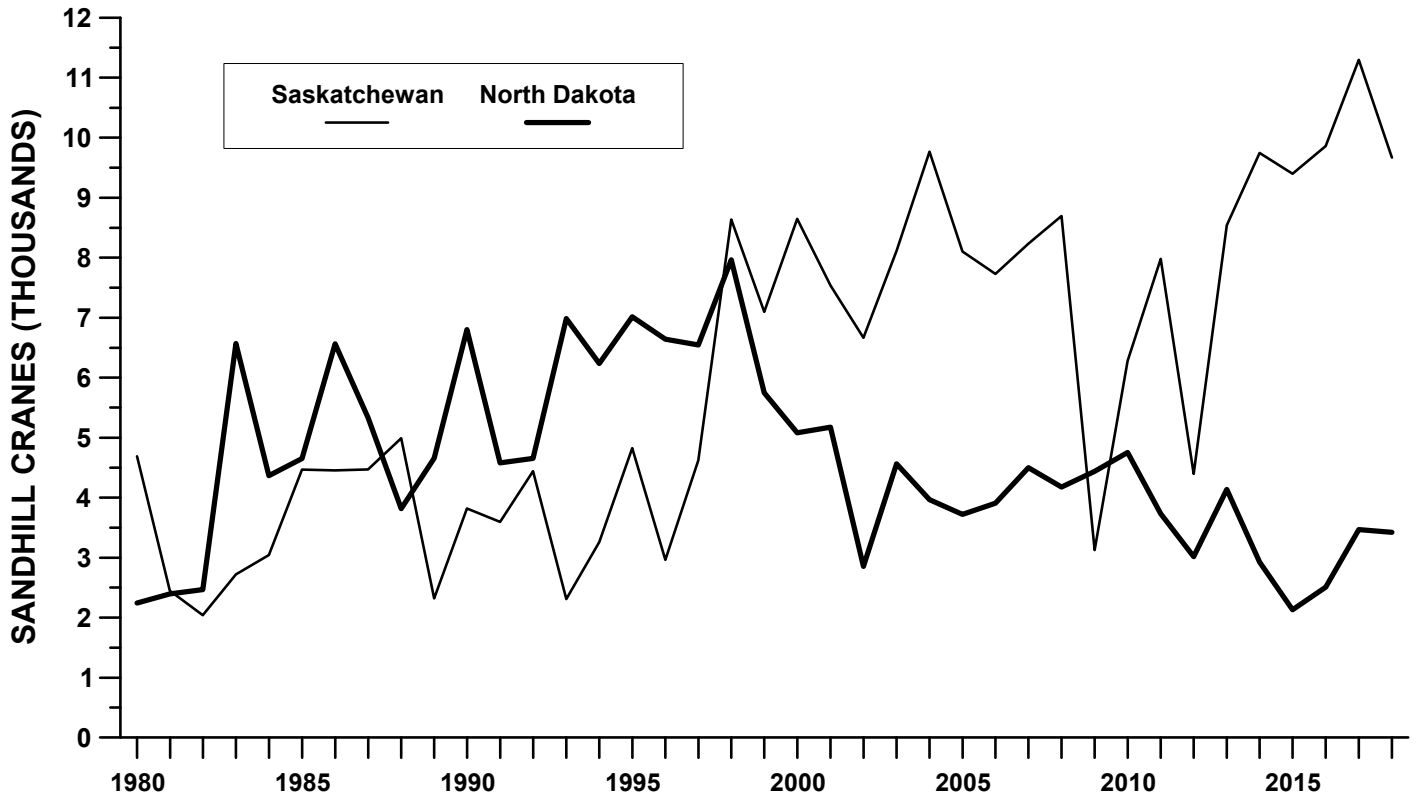
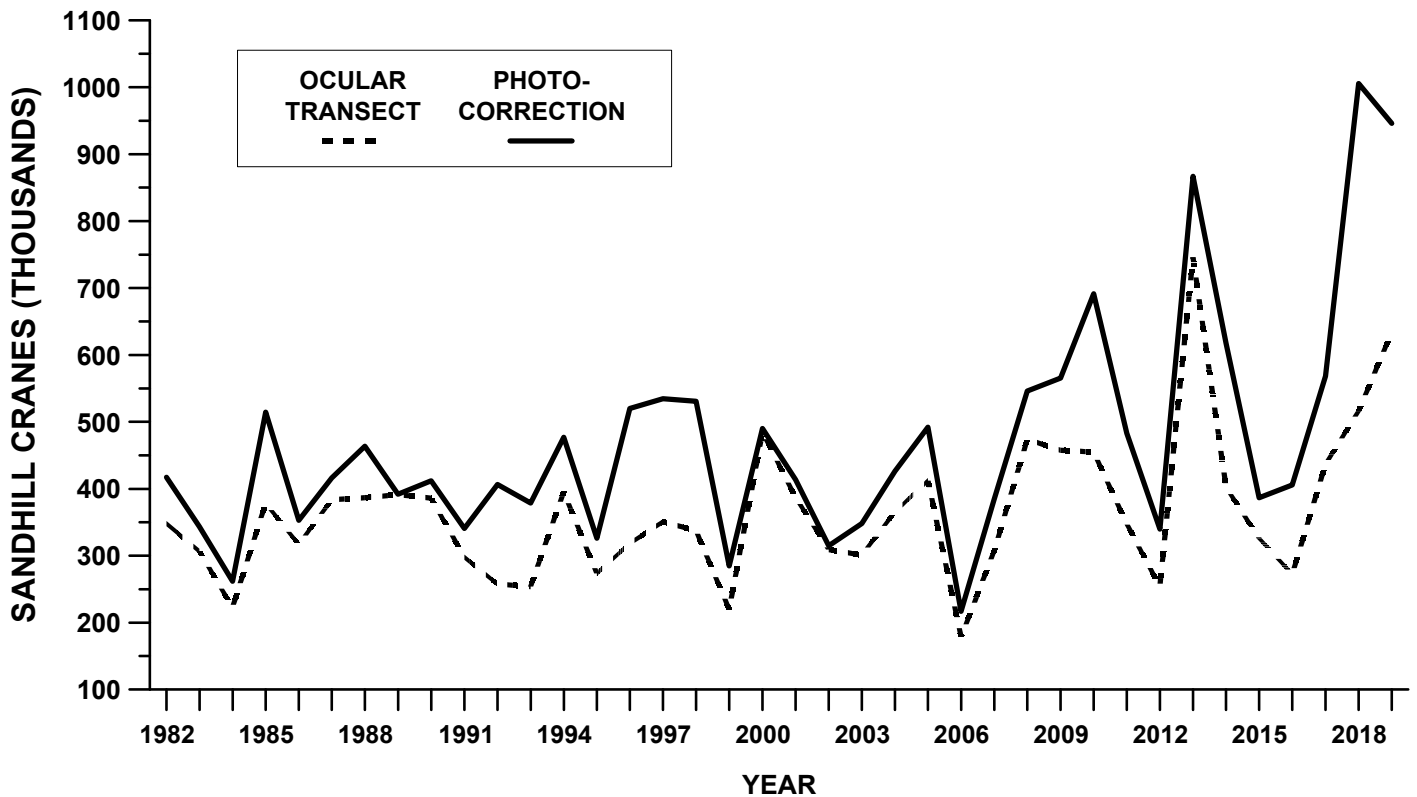
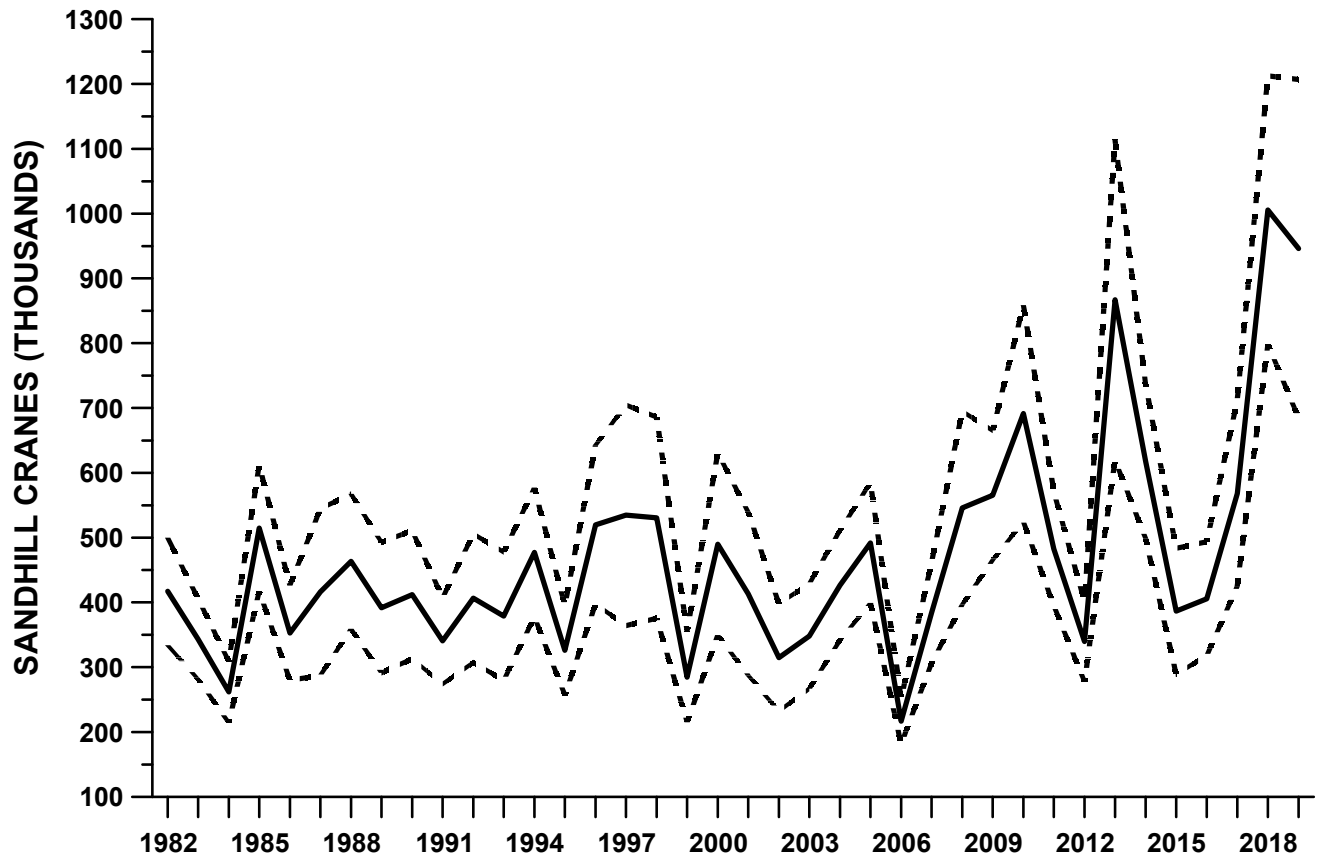


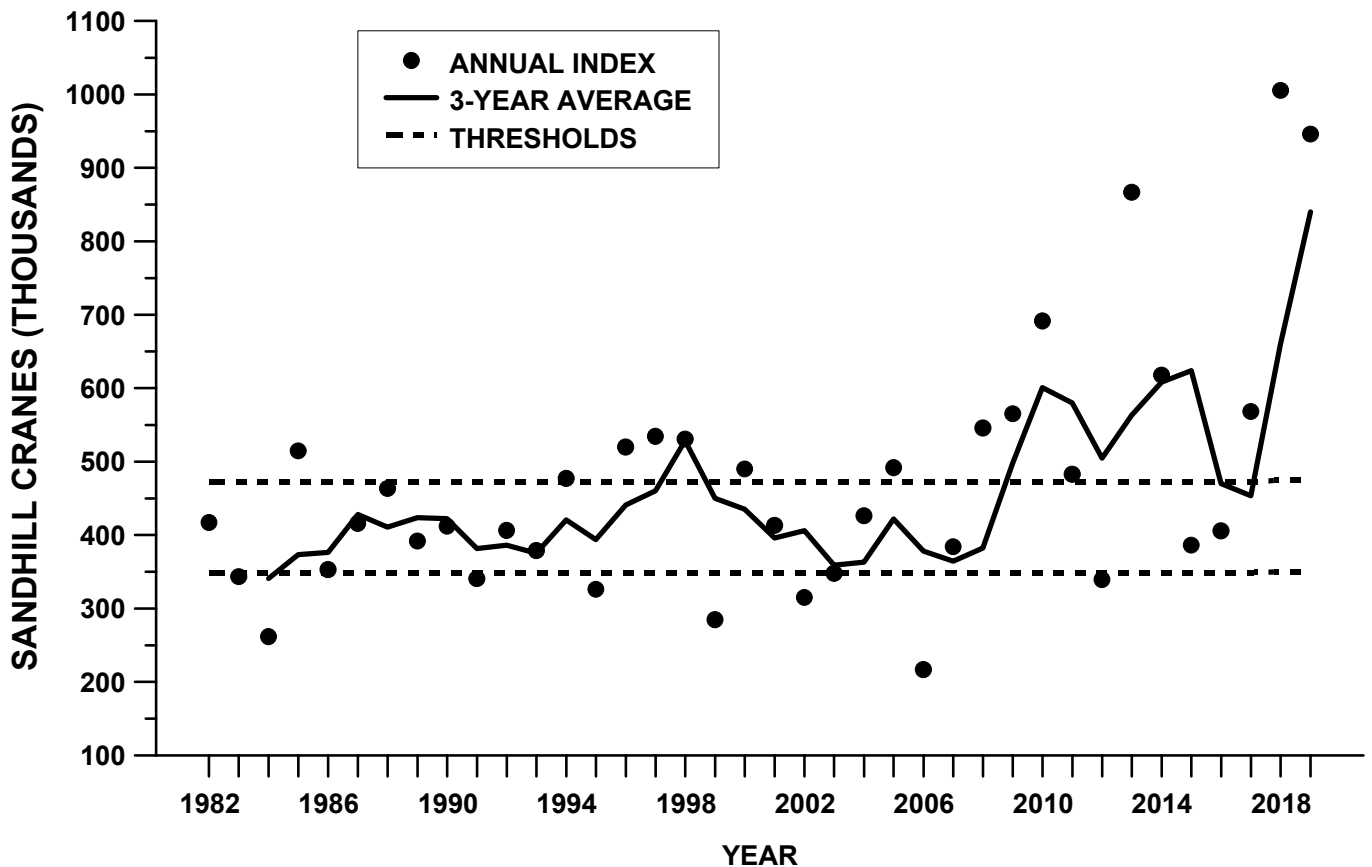
Figure 7. Spring population indices for Mid-Continent sandhill cranes on the Central Platte River Valley, Nebraska.



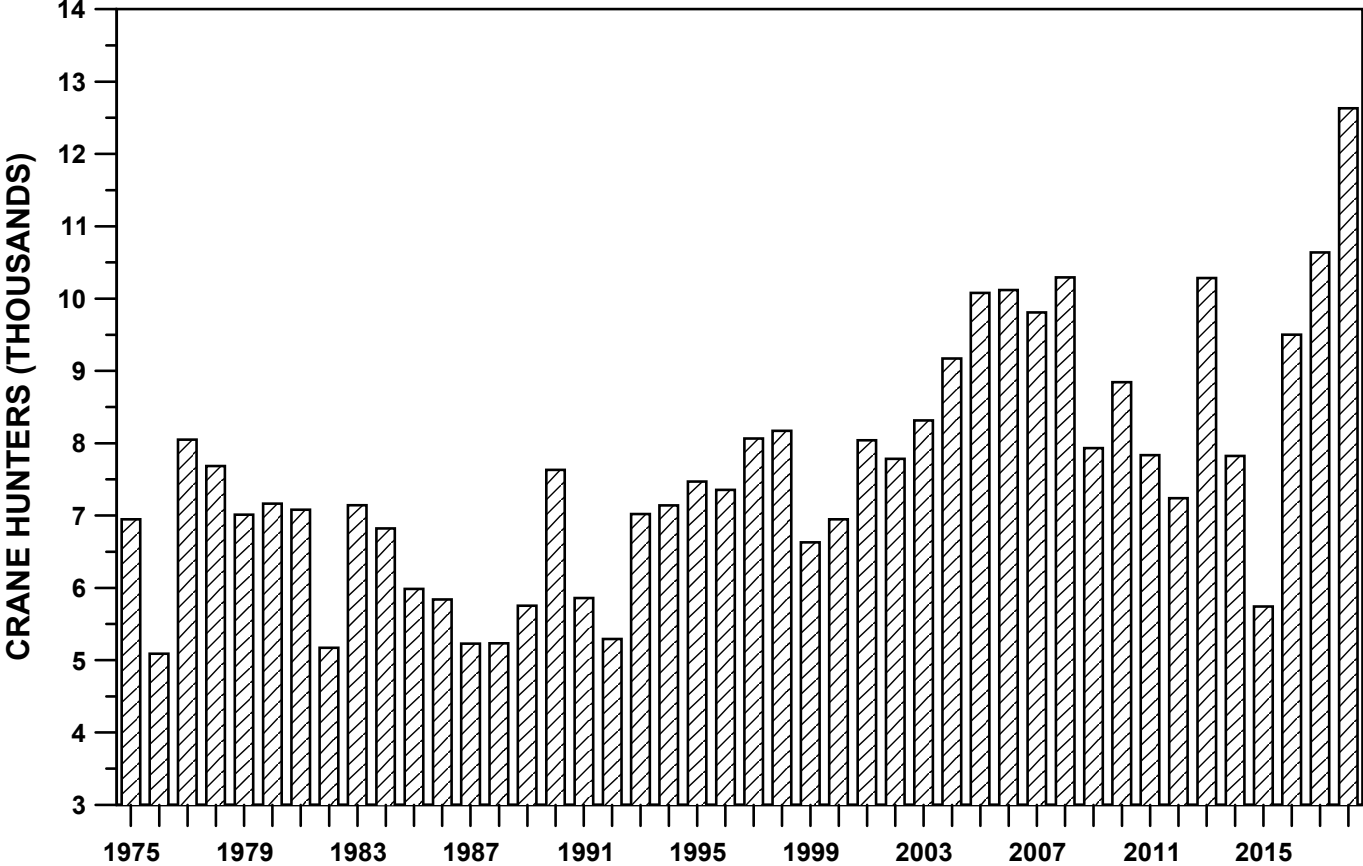
**Figure 8. Photo-corrected spring population estimates (solid line) and the 95% confidence intervals (dashed lines) for Mid-Continent sandhill cranes on the Central Platte River Valley, Nebraska.**



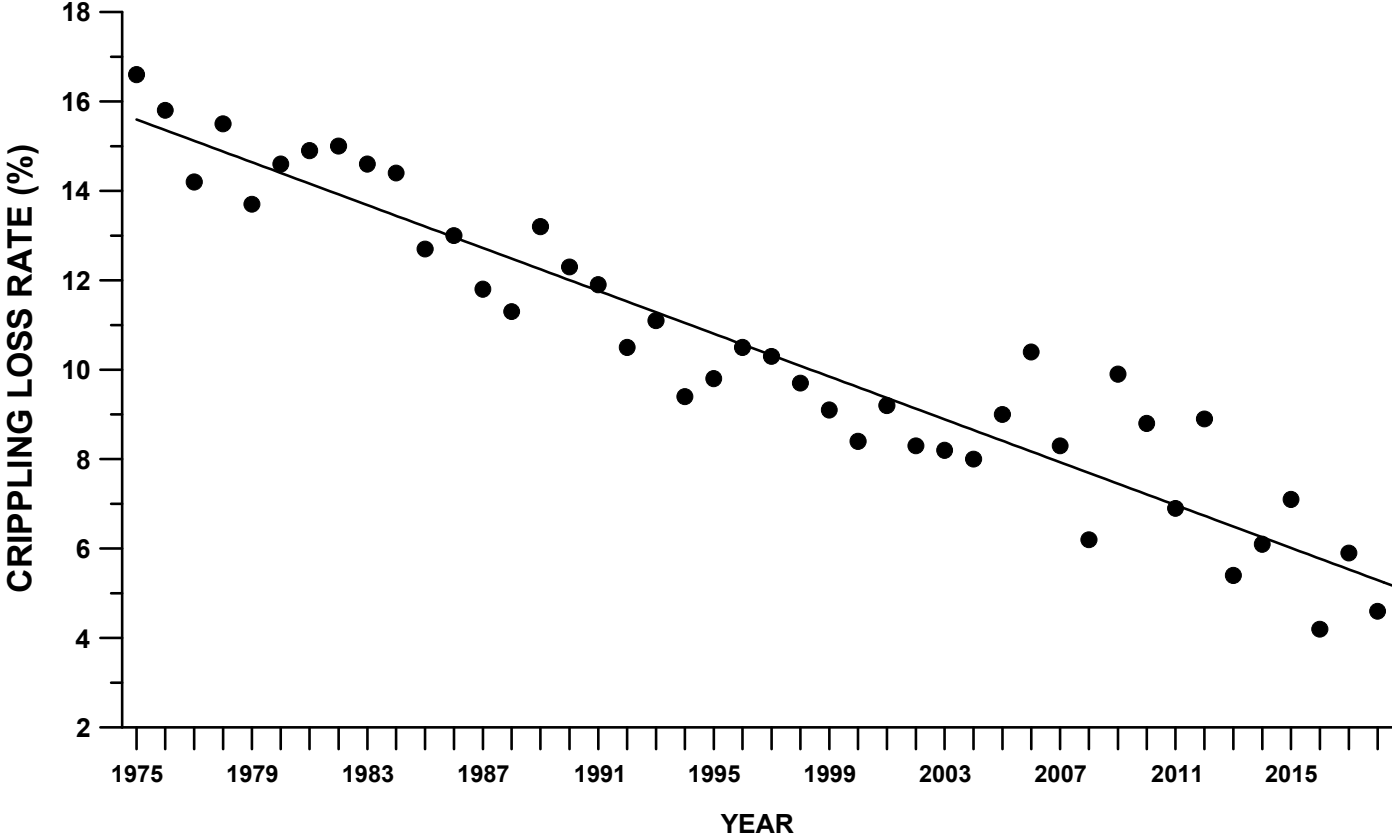
**Figure 9. Annual and three-year average photo-corrected ocular transect spring population indices and population objective thresholds for Mid-Continent sandhill cranes.**



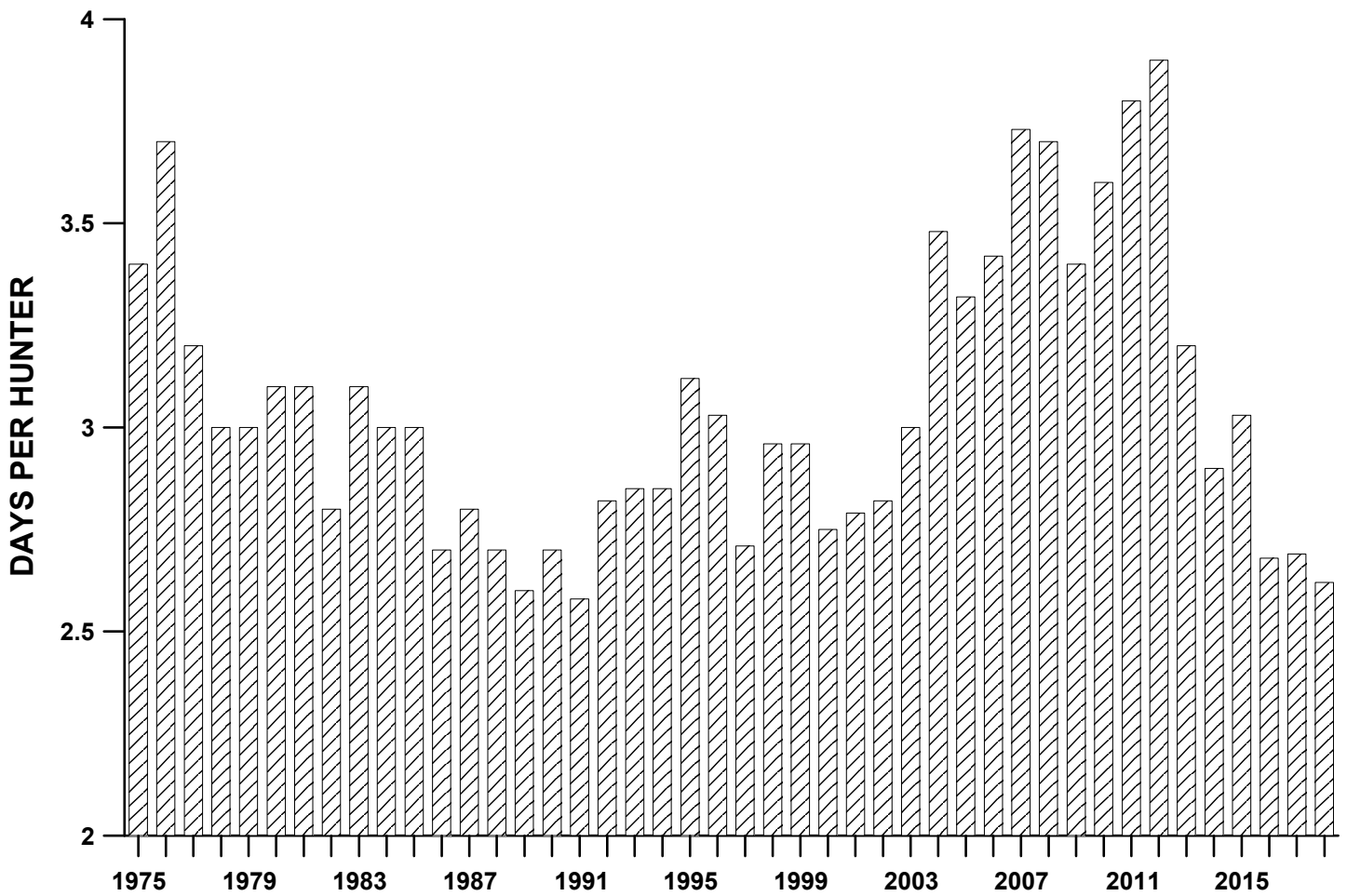
**Figure 10. Active Mid-Continent sandhill crane hunters in the U.S. portion of the Central Flyway.**



**Figure 11. Crippling-loss rate (number lost/[number retrieved + lost]) of Mid-Continent sandhill cranes in the U.S. portion of the Central Flyway.**



**Figure 12. Average number of hunting days afield reported by active Mid-Centriant sandhill crane hunters in the U.S. portion of the Central Flyway.**



**Figure 13. Seasonal bag per Mid-Centriant sandhill crane hunter in the U.S. portion of the Central Flyway.**

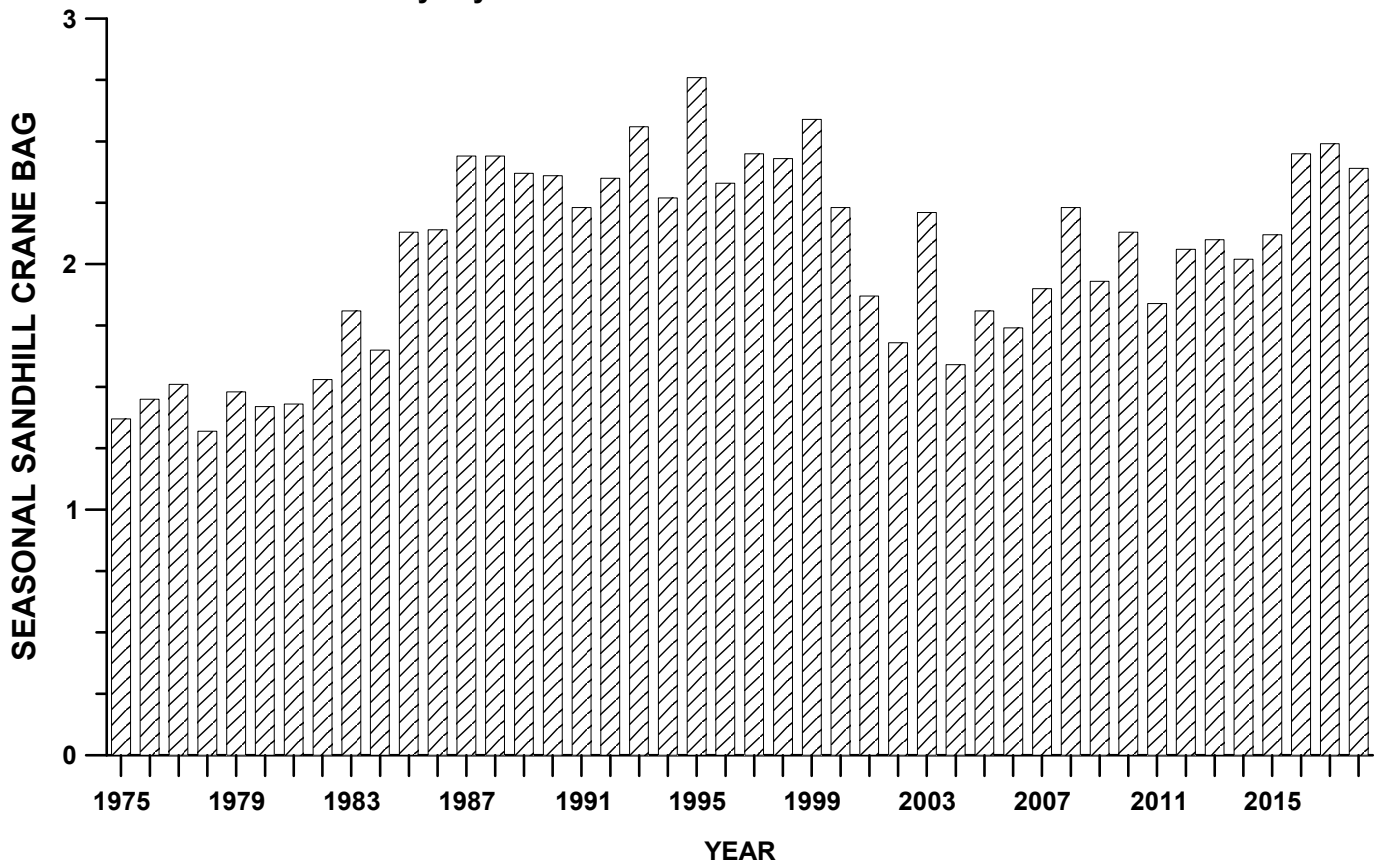


Figure 14. Estimated hunting mortality (retrieved and unretrieved) of Mid-Centroid sandhill cranes in the U.S. portion of the Central Flyway.

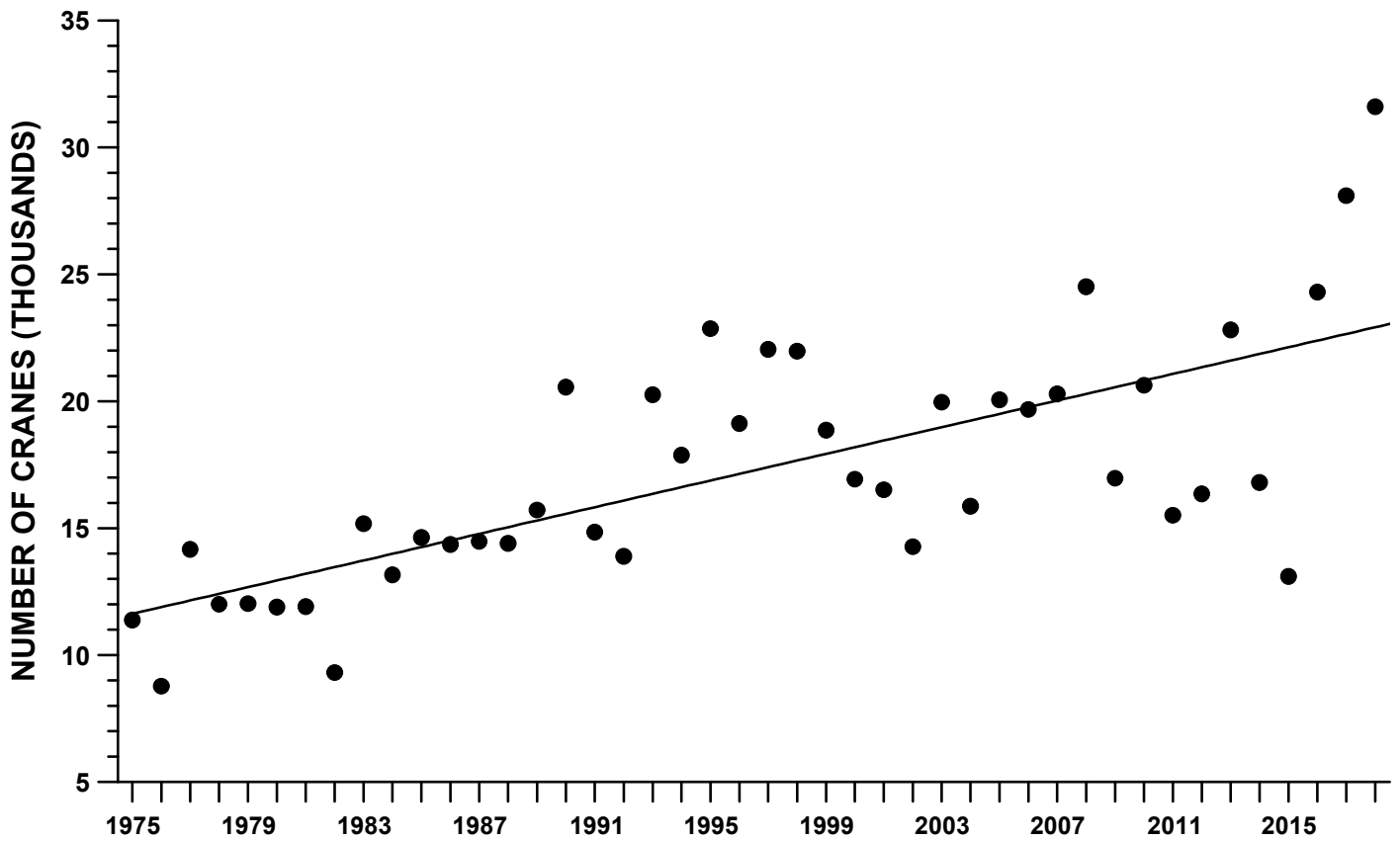
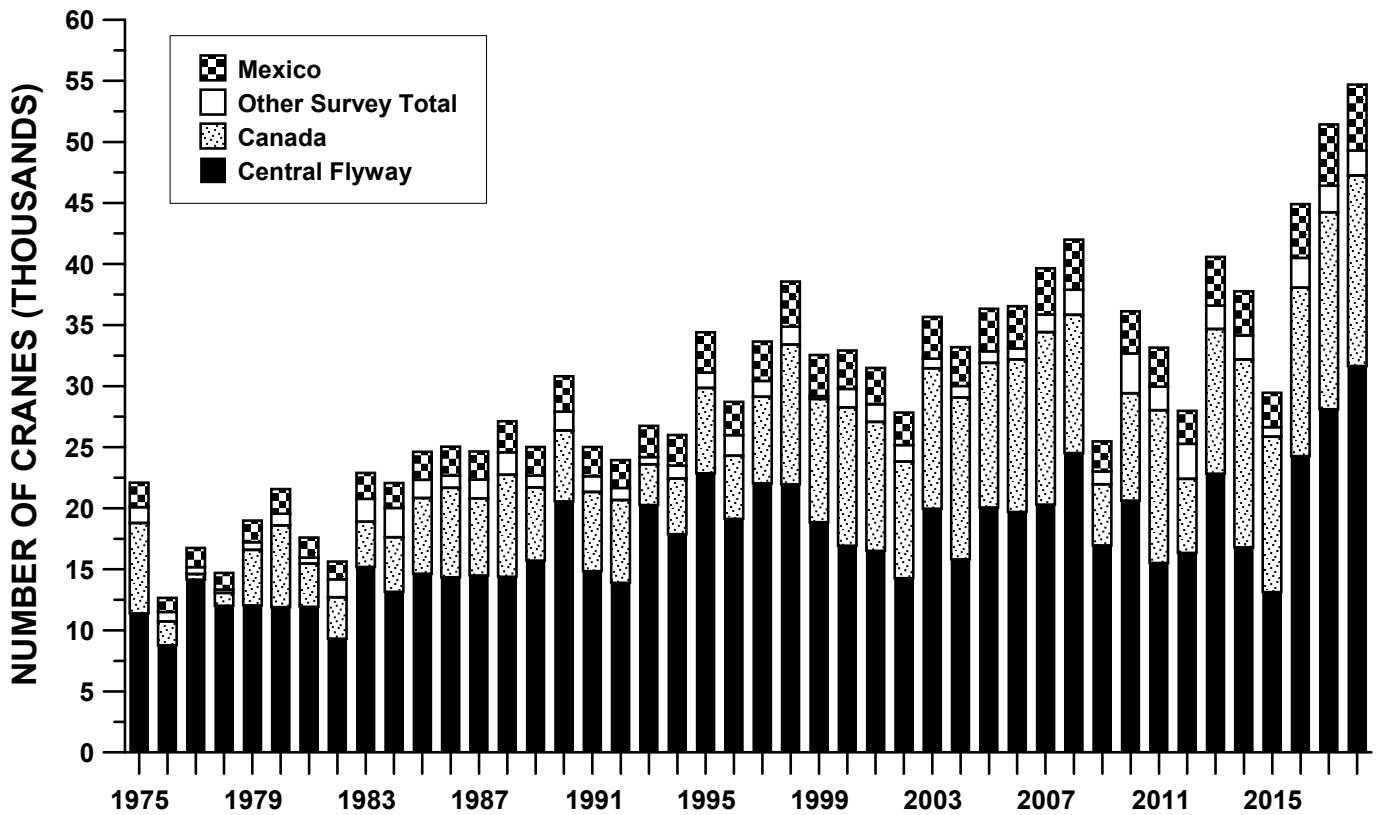


Figure 15. Estimated hunting mortality (retrieved and unretrieved) of Mid-Centroid sandhill cranes in North America . <sup>1,2</sup>



1. In 1999, there was no estimate available for AK.

2. In 2010, MN began hunting MCP in the northwestern portion of the state.

Figure 16. Trend analyses of indices to abundance and harvest of Mid-Continent sandhill cranes.

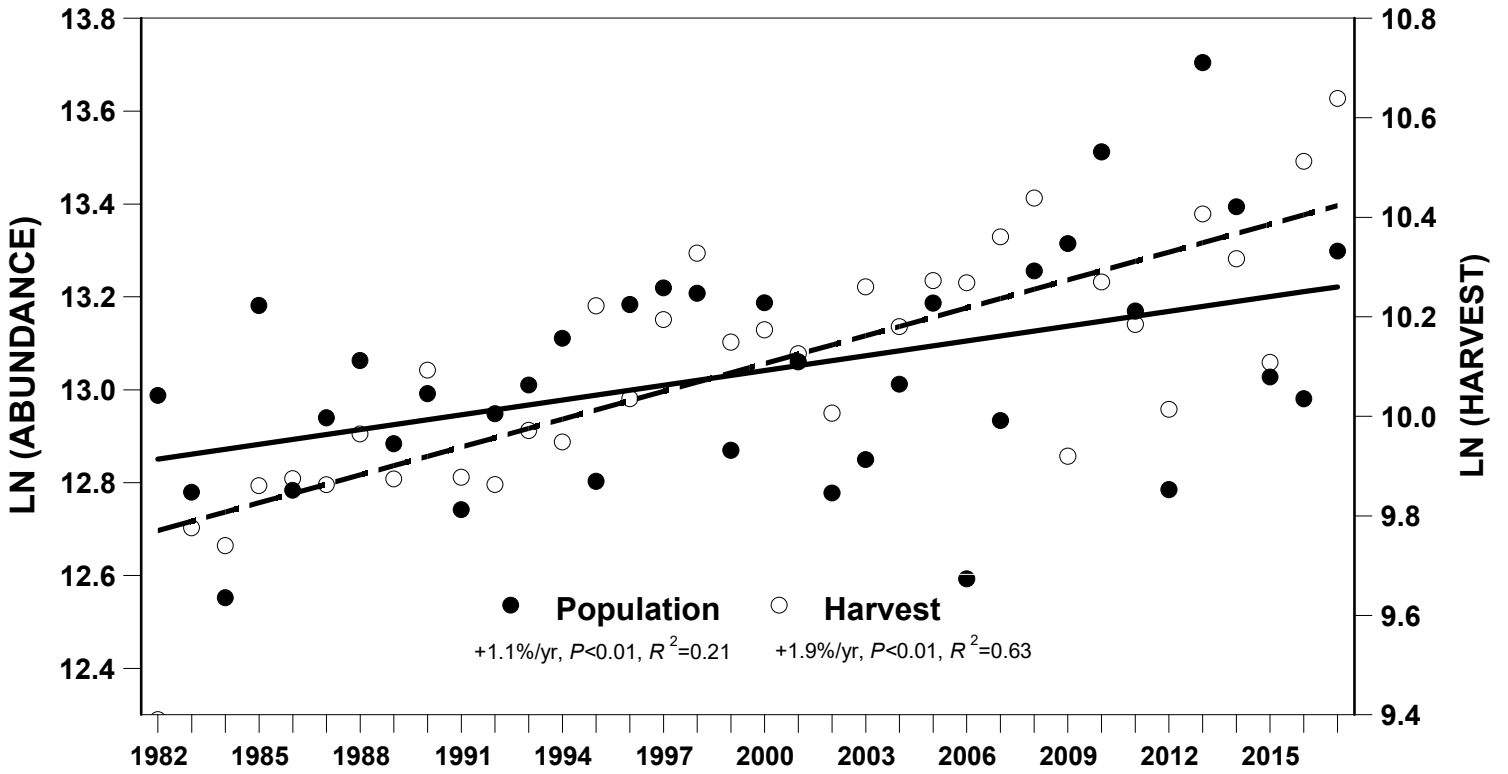


Figure 17. Estimated harvest of Rocky Mountain Population sandhill cranes.

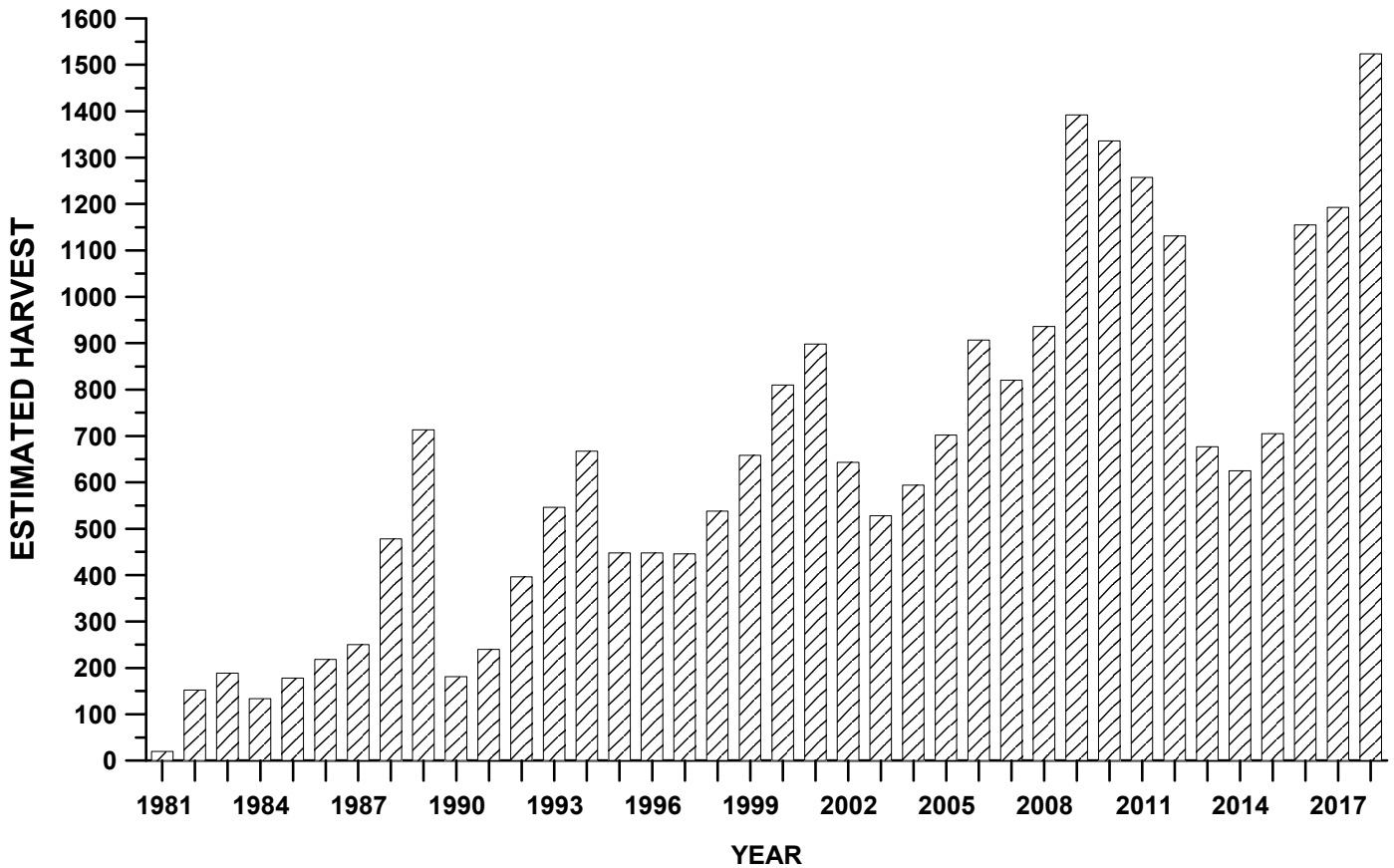




Figure 18. Abundance indices for the Rocky Mountain Population of sandhill cranes.

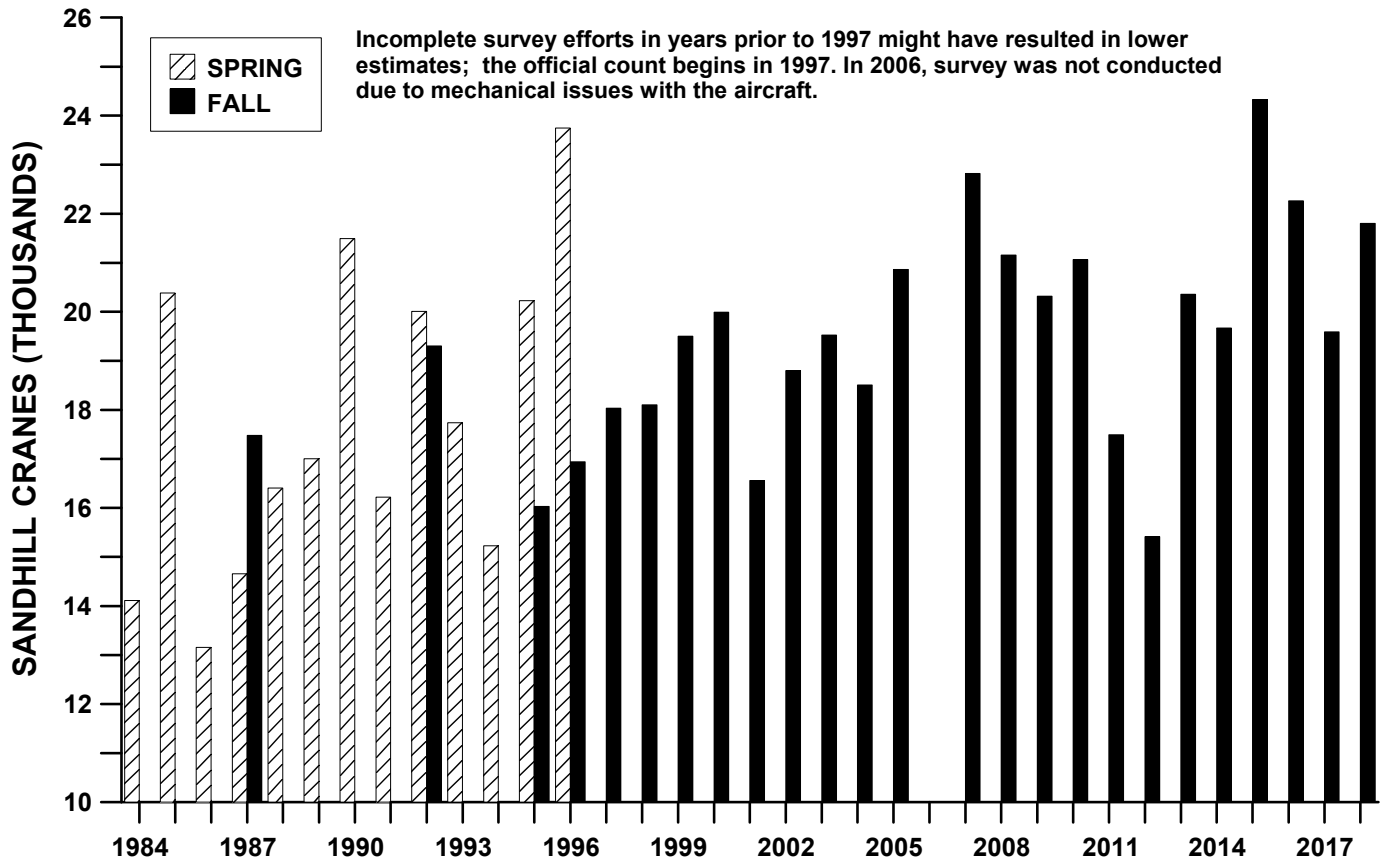


Figure 19. Annual and three-year average of fall pre-migration abundance indices for the Rocky Mountain Population of sandhill cranes.

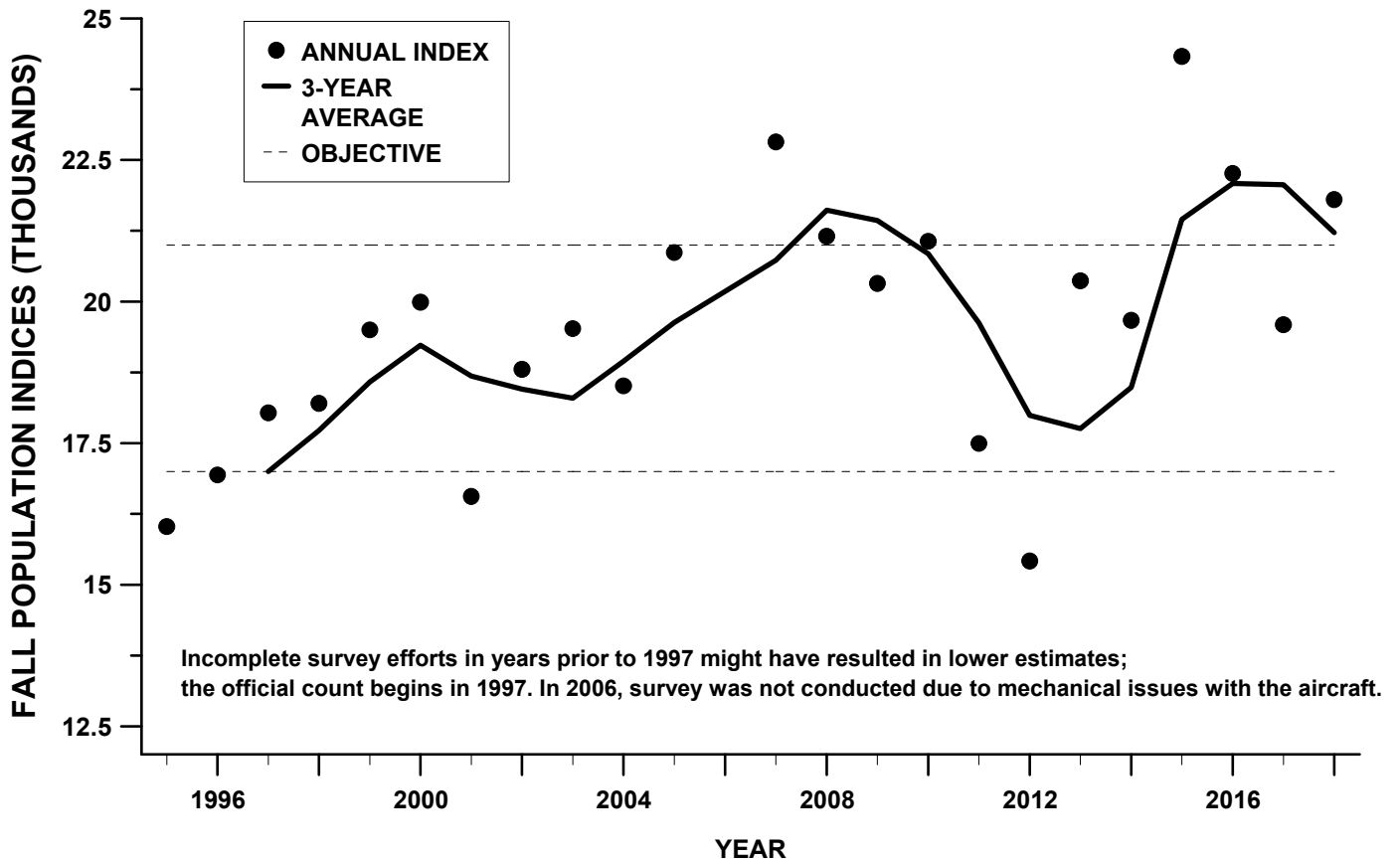


Figure 20. Annual indices for recruitment (% juveniles) of the Rocky Mountain Population of sandhill cranes. Solid line indicates the long-term (1972-2017) average of 8.2.

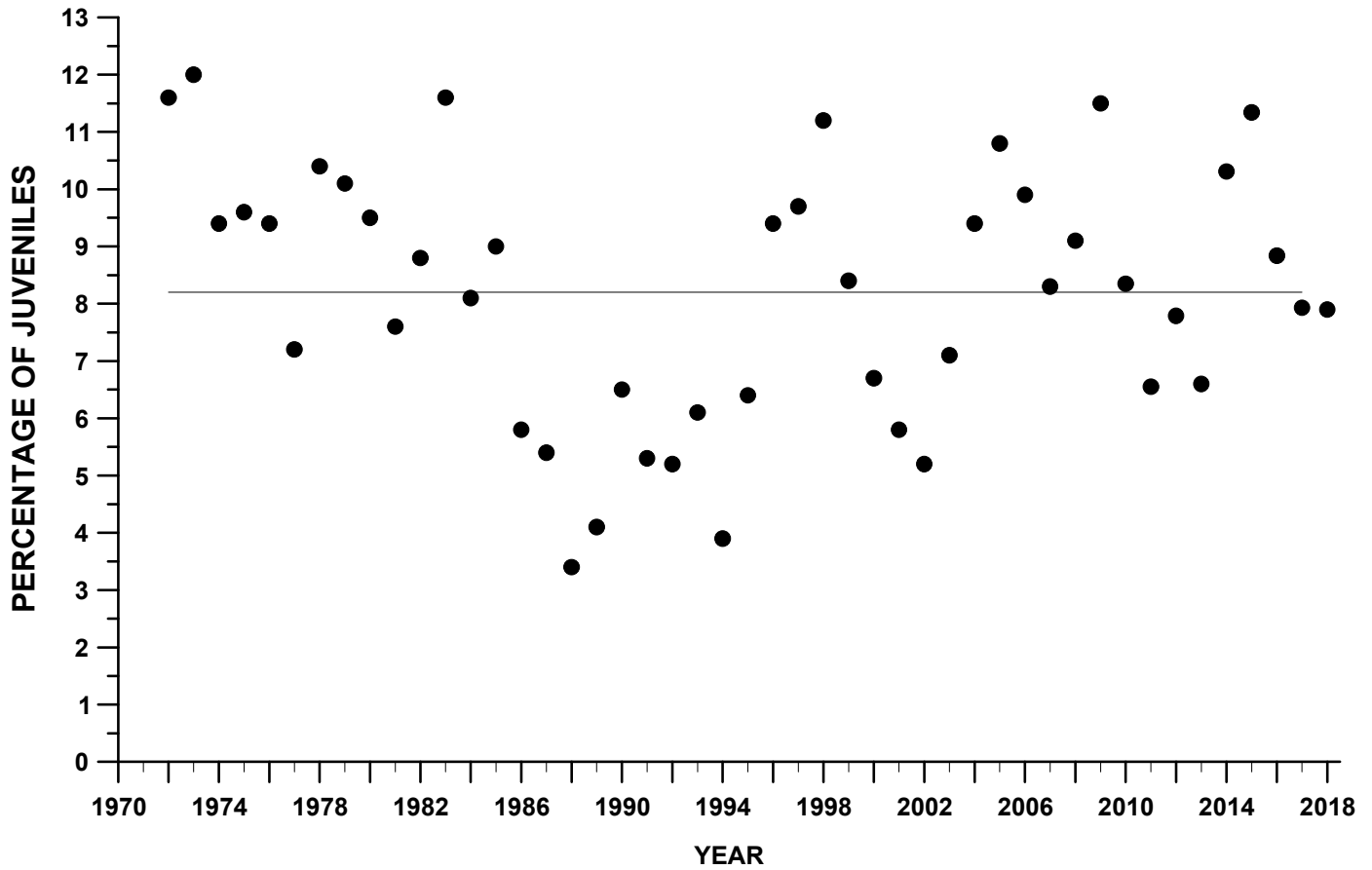
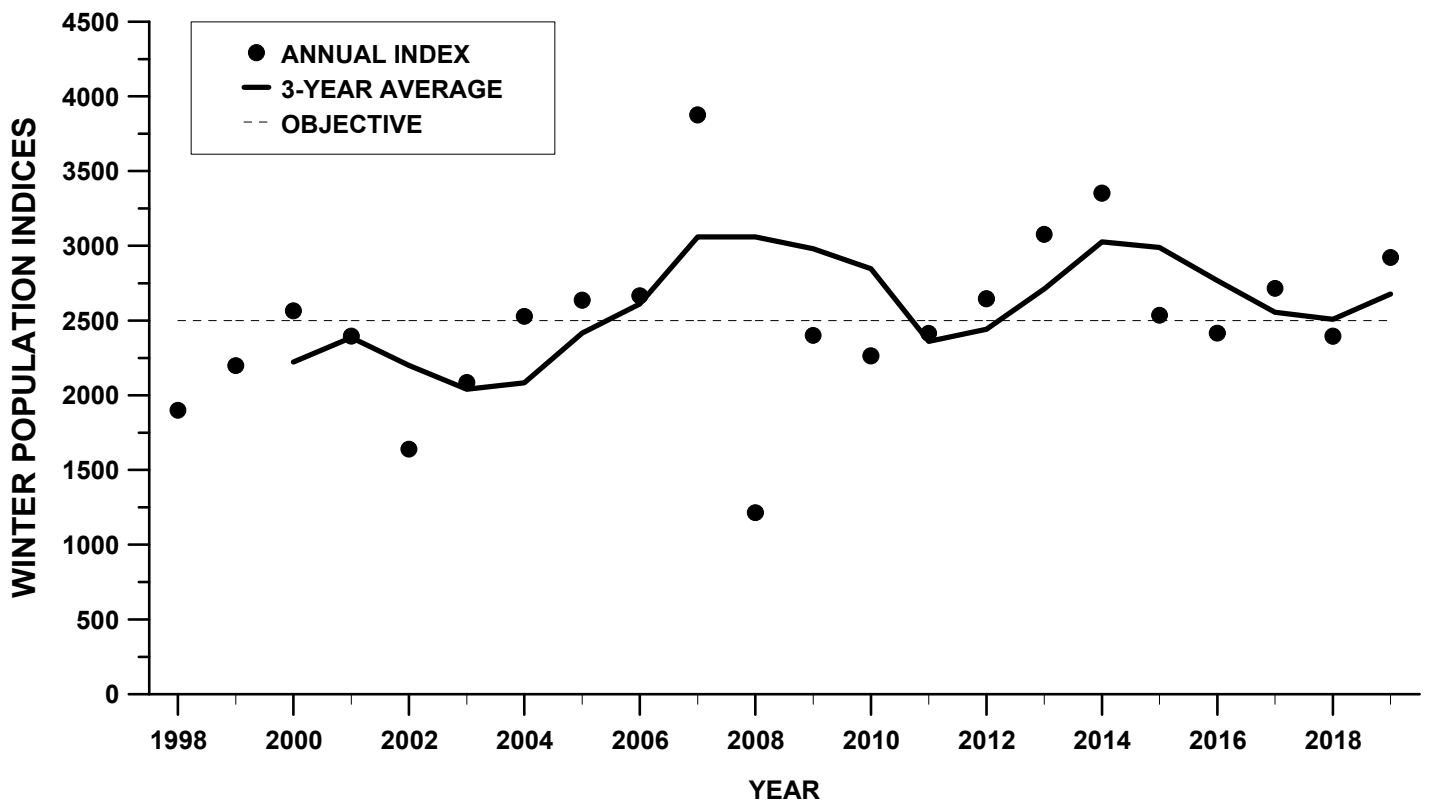
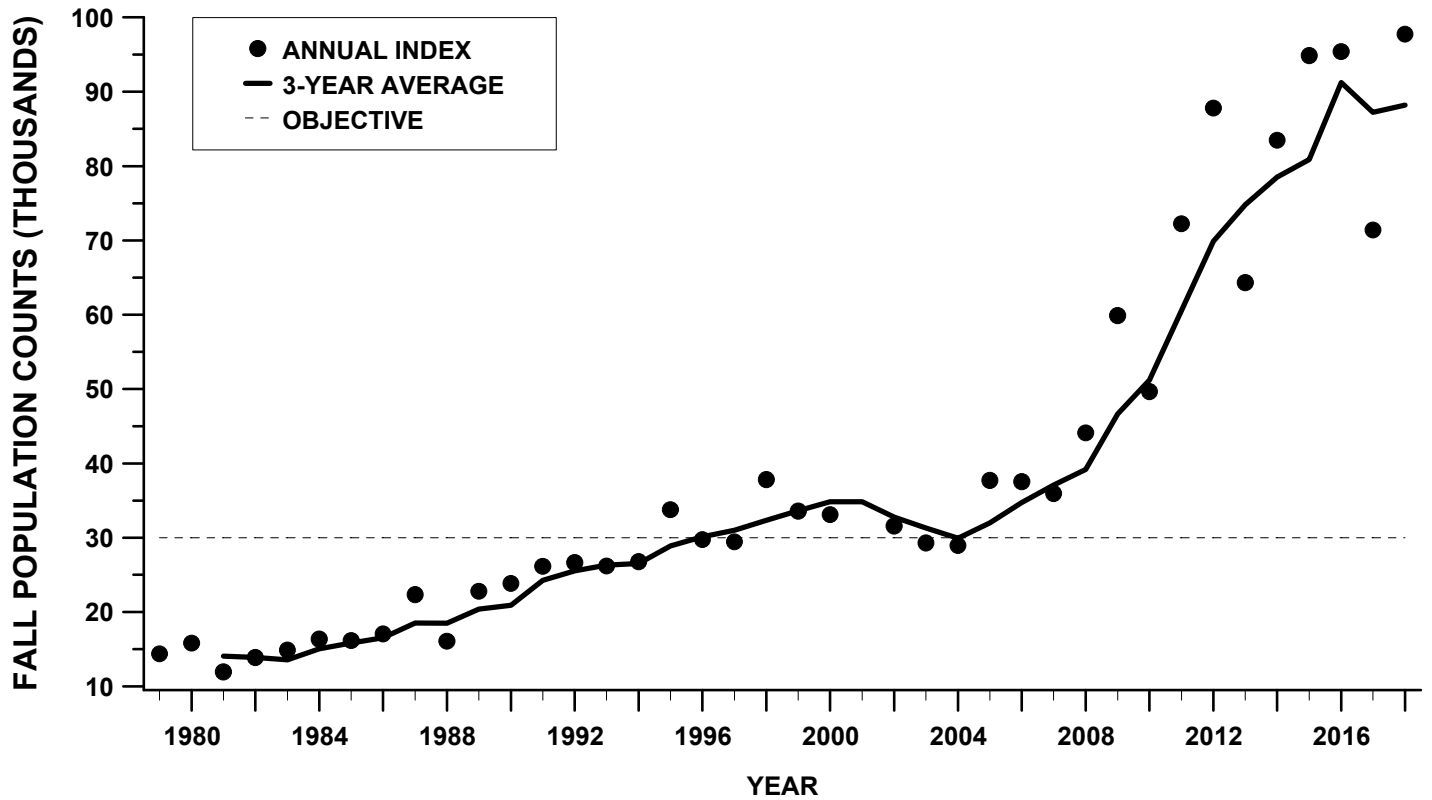


Figure 21. Annual and three-year average of winter counts of the Lower Colorado River Valley Population of sandhill cranes in Arizona and California.



In 2008, the survey was not complete. The 3-YR average for that year was calculated using 2005-07. In 2009 and 2010, the estimate for 2008 was not included in the 3-YR average

Figure 22. Annual and three-year average of fall counts of the Eastern Population of sandhill cranes.



- Survey was not conducted in 2001. The 3-yr average for 2001 was calculated using data from 1998-2000; see Table 12.
- In 2002 and 2003, the 3-yr averages did not include 2001; see Table 12.
- New survey areas are still being added which is partially responsible for the increasing count.

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