Pacific and Central Flyways Management Plan for the

Rocky Mountain Population of Greater Sandhill Cranes

Photo courtesy Dan Collins, FWS

This management plan is one of a series of cooperatively developed plans for managing various populations of migratory birds of the Pacific and Central Flyways. Inquiries about this plan may be directed to member states of the Pacific and Central Flyway Councils or to the Pacific Flyway Representative, U.S. Fish and Wildlife Service, Division of Migratory Bird Management, 1211 SE Cardinal Court, Suite 100, Vancouver, Washington 98683-9684, or to the Central Flyway Representative, U.S. Fish and Wildlife Service/MBMO, 755 Parfet Street, Suite 496B, Lakewood, Colorado 80215.

Suggested citation: Pacific Flyway Council and Central Flyway Council. 2016. Pacific and Central Flyways Management plan for the Rocky Mountain population of greater sandhill cranes. Pacific Flyway Council and Central Flyway Council, care of the U.S. Fish and Wildlife Service's Pacific Flyway Representative, Vancouver, Washington. 47pp.

PACIFIC AND CENTRAL FLYWAYS MANAGEMENT PLAN

FOR THE ROCKY MOUNTAIN POPULATION OF GREATER SANDHILL CRANES

Prepared for the

Pacific Flyway Council
Central Flyway Council
Secretaria de Medio Ambiente Recursos Naturales y Pesca
U.S. Fish and Wildlife Service

by the

Rocky Mountain Population of Sandhill Cranes Subcommittee
of the
Pacific Flyway Study Committee

and the
Central Flyway Webless Migratory Game Bird Technical Committee

March 1982
Revised March 1987
Revised March 1991
Revised July 1997
Revised March 2007
Revised March 2016

Approved by: _____ March 15, 2016
Chairperson, Pacific Flyway Council Date

Approved by: _____ March 15, 2016
Chairperson, Central Flyway Council Date

ACKNOWLEDGEMENTS

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PREFACE

The Pacific and Central Flyway Councils are administrative bodies that forge cooperation among public wildlife agencies for the purpose of protecting and conserving migratory birds. Each Council is composed of the director or an appointee from the public wildlife agency in each state and province in the flyway from the United States, Canada, and Mexico. Migratory birds use four major migratory routes (Pacific, Central, Mississippi, and Atlantic flyways) in North America. Because of the unique biological characteristics and relative number of hunters in these regions, state and federal wildlife agencies adopted the flyway structure for administering migratory bird resources within the United States. Each flyway has its own Council.

Flyway management plans are developed by Council technical committees and include biologists from state, federal, and provincial wildlife and land-management agencies, universities, and others. Management plans typically focus on populations, which are the primary unit of management, but may be species or subspecies specific. Management plans identify issues, goals, and actions for the cooperative management of migratory birds among State and Federal agencies to protect and conserve these birds in North America. Management of some migratory birds requires coordinated action by more than one flyway. Plans identify common goals and objectives, establish priority of management actions and responsibility for them, coordinate collection and analysis of biological data, foster collaborative efforts across geo-political boundaries, document agreements on harvest strategies, and emphasize research needed to improve conservation and management. Population sustainability is the first consideration, followed by equitable recreational and subsistence harvest opportunities. Management plans generally have a 5-year planning horizon, with revisions as necessary to provide current guidance on coordinated management. Management strategies are recommendations and do not commit agencies to specific actions or schedules. Fiscal, legislative, and priority constraints influence the level and timing of management activities.

Management plans are not intended as an exhaustive compendium of information available, research needed, and management actions. Plans include summaries of historical data and information from recent surveys and research that help identify: (1) the current state of the resource (i.e., population), (2) desired future condition of the resource (i.e., population goals and objectives), (3) immediate management issues managers face, and (4) management actions necessary and assignment of responsibilities to achieve the desired future condition, including harvest strategies and monitoring to evaluate population status and management progress.

The first Pacific Flyway management plan for the Rocky Mountain Population of Sandhill Cranes was adopted March 1982. This document is the fifth revision of that plan. It was developed by the Pacific Flyway Study Committee, Rocky Mountain Population Sandhill Crane Subcommittee, and the Central Flyway Webless Migratory Game Bird Technical Committee.

ACRONYMS USED

AGFD	Arizona Game and Fish Department
CFWMGBTC	Central Flyway Webless Migratory Game Bird Technical Committee
CPW	Colorado Division of Parks and Wildlife
FWS	U.S. Fish and Wildlife Service, Department of the Interior
MCP	Mid-continent Population
MRGV	Middle Rio Grande Valley, New Mexico
NRCS	Natural Resources Conservation Service
NWR	National Wildlife Refuge
RMP	Rocky Mountain Population of greater sandhill cranes
SLV	San Luis Valley, Colorado
WGFD	Wyoming Game and Fish Department
Wildlife Services	U.S. Dept. of Agriculture-Animal and Plant Health Inspection Services-Wildlife Services
WMA	Wildlife Management Area

PACIFIC AND CENTRAL FLYWAYS MANAGEMENT PLAN FOR THE ROCKY MOUNTAIN POPULATION OF GREATER SANDHILL CRANES

INTRODUCTION

Five populations of greater sandhill cranes (*Grus canadensis tabida*) have been identified in North America. These include the Eastern, Rocky Mountain, Lower Colorado River Valley, Central Valley populations, and the of Mid-Continent (made up of greater, lesser [*G. c. canadensis*] and Canadian [*G. c. rowani*] subspecies) sandhill cranes (Braun et al. 1975, Lewis 1977, Tacha et al. 1984). The 2015 Status and Harvest of Sandhill Cranes (Kruse and Dubovsky 2015) reports 3-year average population estimates as follows: Mid-Continent Population 648,616; Eastern Population 78,532; Rocky Mountain Population 18,482; Lower Colorado River Valley Population 2,989.

Numbers and distribution of Rocky Mountain Population (RMP) cranes, expanded markedly from 400–600 birds in the mid-1940s (Walkinshaw 1949) to 10,000–15,000 birds by 1971 (Drewien and Bizeau 1974). Their current breeding range includes portions of Montana, Idaho, Wyoming, Utah, and Colorado (Fig. 1). Recent records confirm breeding in extreme southwestern Alberta, which probably involve RMP pioneers following the Rocky Mountain Front northward from Montana (Semenchuk in Drewien et al. 2001). Johnson, Natrona, and Sheridan counties in Wyoming are reporting the presence of cranes during summer, which may indicate these birds are moving further east (Tessmann, Wyoming Game and Fish Department [WGFD], personal communication).

The major spring and fall migration staging area is the San Luis Valley (SLV), Colorado, where virtually the entire population spends 3–4 months annually (Drewien and Bizeau 1974, Kauffeld 1982). Several important overnight stopovers are used by RMP cranes during spring and fall migration including Harts Basin and the Grand Valley, Colorado, the Green River near Jensen to Ouray National Wildlife Refuge (NWR) in Utah (Drewien and Bizeau 1974, Peterson and Drewien 1997) and Cochiti and Jemez reservoirs, New Mexico (Stahlecker 1992).

The principal wintering area is the Middle Rio Grande Valley (MRGV), New Mexico. Smaller numbers winter in southwestern New Mexico, southeastern Arizona, and the northern highlands of Mexico (Drewien and Bizeau 1974, Perkins and Brown 1981, Drewien et al. 1996). On winter areas, RMP cranes mix with the Mid-continent population (MCP), and cannot be managed separately (Lewis 1977, Drewien and Bizeau 1974, Drewien et al. 1996).

The distribution of RMP cranes between the Pacific and Central flyways continues to be dynamic, in response to changing land use, climate, and likely other factors. Complementary planning between all jurisdictions is needed to ensure coordinated management of the RMP is based on shared objectives and the best available information.

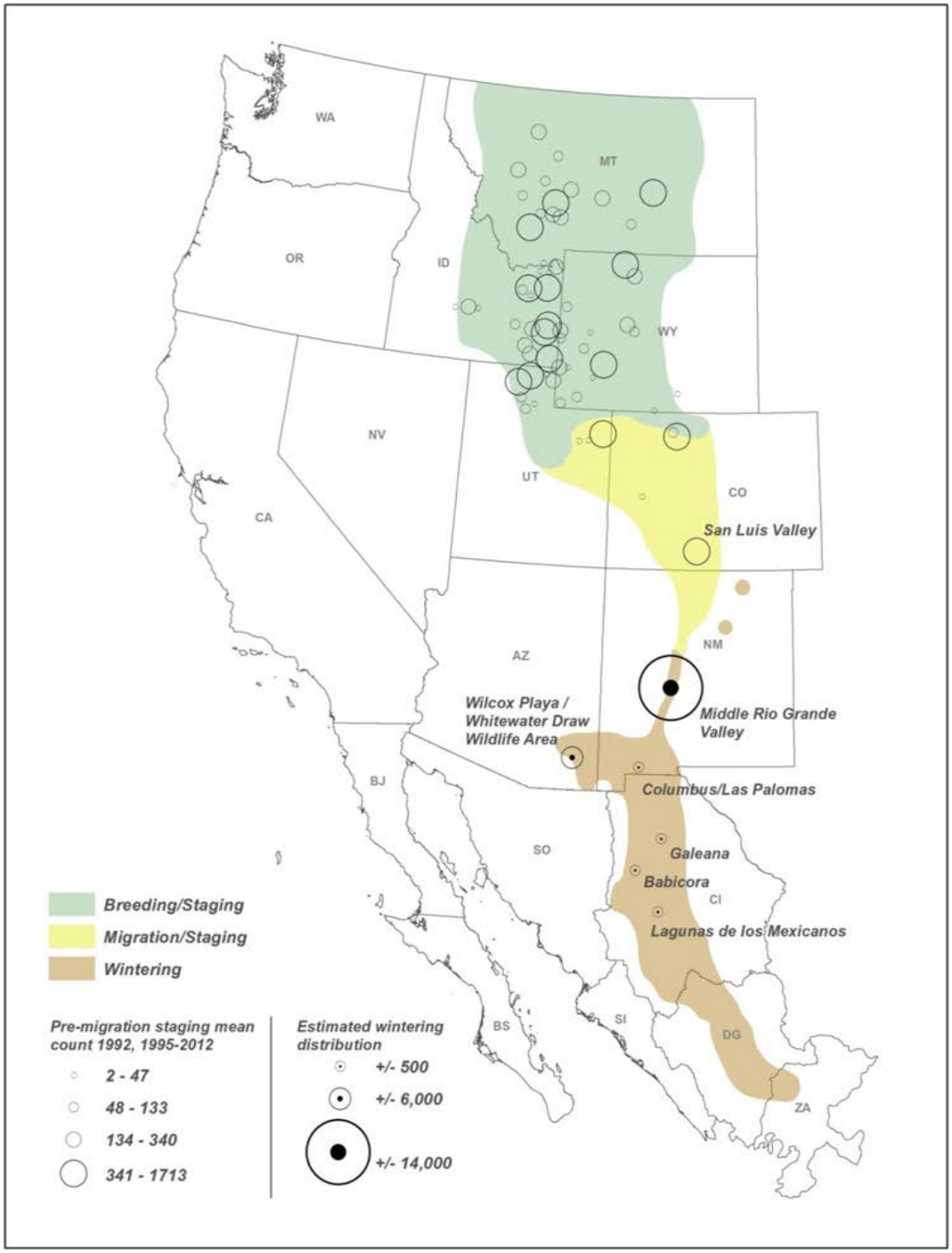

Figure 1. Distribution of the Rocky Mountain population of greater sandhill cranes (Donnelly and Vest 2014 [adapted from Drewien et al. 2001]).

This plan is a revision of the March 2007 RMP crane plan. The plan addresses habitats (breeding range, fall staging areas, migration routes, fall and spring stopover areas, and winter areas), status, uses, current management, problems associated with the population, and crane hunting guidelines.

GOALS AND OBJECTIVES

The goal is to manage RMP cranes to ensure long-term conservation, meet needs for consumptive and non-consumptive uses, and minimize depredation and nuisance concerns.

Objectives

1. Maintain the population between 17,000–21,000 cranes as measured by the recent 3-year average index of total cranes from the September pre-migration survey.

   A crane population of 19,000 (± 2,000) provides numerous opportunities for viewing, recreational hunting, and does not result in intolerable crop damage in most areas. There is currently sufficient habitat to support the population objective. A population in excess of 21,000 cranes may significantly increase the probability of crop damage, disease related mortality and overcrowding, particularly in the primary MRGV winter area. Conversely, a population of less than 17,000 reduces opportunities for consumptive and non-consumptive uses.

   Most RMP cranes stage in specific locations throughout the summer range states during late August to early October, but migration chronology can vary between years. The September pre-migration timeframe provides the best opportunity to survey this population. The population objective of this plan will be based on September surveys. To minimize the potential effect of a poor count during a single year, population management decisions will be based on an average of the three most recent, reliable (defined on page 32) September pre-migration surveys.

2. Maintain and protect suitable habitats in sufficient quantity and quality to support the population objective and recent past spatial distribution (Table 1), while encouraging population expansion where desirable.

   Sufficient breeding, wintering, and migration habitat is required to maintain a stable population. Some areas of historic range suitable for nesting pairs are currently not occupied, and some staging and wintering areas are overcrowded (Subcommittee on Rocky Mountain Sandhill Cranes 2007). Breeding birds pioneering into unoccupied areas should be encouraged to expand, and migrating and wintering birds may be encouraged to use alternate areas through various management practices (e.g., creation of food plots, new roost sites, or protected areas). Cooperative management between state management areas and federal refuges could significantly improve spatial distribution and habitat for cranes.

   Increasing human impacts on crane habitats will likely result in short and long-term habitat loss. As habitat is lost due to changing agricultural practices and crops, cranes are restricted

to fewer areas. Food supply, roost sites, and overcrowding are becoming priority concerns for population maintenance, especially on winter areas (Mitchusson 2003).

3. Provide for recreational uses of RMP cranes.

   Due to their large size and palatability, sandhill cranes have long been hunted for food. Crane remains were found in ancient kitchen middens at Wupatki Pueblo, Arizona and in Rio Grande pueblos (Walkinshaw 1949). Crane hunting is the primary tool for reducing localized crop damage. In most states, demand exceeds the availability of permits (Lockman et al. 1987). Crane hunting alleviates many potential depredation complaints and garners support for crane management.

   Watching and photographing sandhill cranes is a popular activity. Expenditures by birders was nearly $41 billion in 2011, and 60% of birders reported observing waterbirds (U.S. Fish and Wildlife Service 2011). Crane festivals attract birders from across the country and other nations to view and photograph wildlife, and participate in other wildlife-related events contributing to the local economies (Case and Sanders 2009).

4. Minimize crop depredations by RMP cranes.

   Large numbers of cranes use private lands in the Rocky Mountain region. Cranes forage primarily in agricultural areas, and may cause significant damage to agricultural crops. Some landowners tolerate crane use on private lands, while others have been quite vocal and have filed complaints with the U.S. Department of Agriculture-Animal and Plant Health Inspection Service-Wildlife Services (Wildlife Services) and state agencies. Hunting seasons are the most effective means to reduce sandhill crane depredations, provide recreational opportunity, and improve crane spatial distributions. Crane hunting, along with hazing and timed crop manipulations on refuges can be used to encourage crane use on refuges and reduce agricultural damage (Taylor 1999).

STATUS

Abundance and Trends

Historically, the SLV in March was the best location to census RMP cranes. Virtually the entire population is in the valley between 5–15 March. Beginning in March 1984, the U.S. Fish and Wildlife Service (FWS) annually counted cranes in the SLV using a systematic aerial transect survey with a photographic correction factor (Benning et al. 1997). Adverse weather conditions, including partial snow cover and high winds, occasionally reduced visibility, producing some counts of questionable accuracy.

During early years of the March survey, a small number of MCP lesser sandhill cranes (<5%) mixed with the RMP. Ground surveys provided an index of the presence of lesser sandhill cranes, and the RMP counts were adjusted accordingly. Between 1993 and 1996, MCP (greater, lesser, and Canadian subspecies) abundance increased significantly, making the total estimated crane count in the SLV 22–33% higher.

The Pacific Flyway and Central Flyway RMP sandhill crane subcommittees concurred with the assessment by Drewien and Benning (1996, personal communication) that spring counts do not provide a reliable population estimate for the RMP. The spring survey was abandoned in 1997 and was replaced with a September pre-migration survey in the summer range states. The time period in September for a reliable survey is relatively brief and is weather dependent, but the population is temporally and spatially isolated from other subspecies. Recent satellite telemetry data indicate possible intermingling of RMP cranes with Lower Colorado River Valley population of cranes (Collins et al 2015). Regardless, September surveys in the pre-migration areas continue to form a solid basis to derive population indices for management decisions.

Coordinated surveys must be done within a minimal time frame to avoid duplicate counting or missing birds that move. Surveys of the RMP on the September pre-migration staging areas provide an underestimate of true abundance of the fall population because the counts are not corrected for birds present but not seen by aerial survey crews and that some hunting mortality in the survey area has already occurred during early September seasons.

Recruitment rates at Grays Lake were high, 13–14% during 1961–1971. However, population recruitment rates recorded in the SLV declined during the late 1980s–mid-1990s (Drewien et al. 1995). The 1982–1985 average recruitment of young was 8.3% and the 1986–1995 average was 5.2%. Drewien's studies indicate decreased production was caused by drought conditions, during which predation on young increased. An apparent increase of predation by coyotes coincided with changes in predator control practices including elimination of compound 1080 by the FWS beginning in 1972.

Below normal recruitment from 1986–1995 had reduced the population from the 1985 level of 20,382. Habitat deterioration (long-term drought and poor wetland conditions) and predation are cited as the primary factors impacting recruitment (Drewien et al. 1995). Changes in farming practices in the SLV also may impact food availability for pre-nesting cranes during the spring migration. However, recruitment rebounded to 9.4% in 1996 in response to improved wetland conditions on breeding areas. The recruitment rate from 1972 to 2015 averaged 8.2% (Fig. 2). The most recent 3-year average (2013–2015) was 9.6% and the 2015 recruitment rate was 11.3% (Brown 2015). Hunting in the northern states occurs prior to the SLV recruitment survey in addition to other mortality factors occurring during migration. This may influence observed recruitment, as juveniles have higher mortality rates (Drewien et al. 2001).

Nesting Biology

Reproduction.—Sandhill cranes are perennially monogamous with pair bonds maintained outside the breeding season (Walkinshaw 1949; Tacha et al. 1992, 1994). Greater sandhill cranes have successfully nested in their third year (Lewis 1977). However, the most productive RMP cranes were >7–8 years old (Drewien et al. 2001). Pair bonds may form and dissolve before successful reproduction occurs (Nesbitt and Wenner 1987). Following successful reproduction, mate changes are rare unless a mate dies (Tacha 1988, Nesbitt 1989). RMP cranes arrive at Grays Lake, Idaho, during late March or early April when the valley is still snow-covered (Dan Collins

U.S. Fish and Wildlife Service, personal communication). In mid-April as weather moderates and snow levels decline, pairs disperse to breeding territories (Drewien 1973).

After arrival, most breeding pairs establish territories 2–4 weeks before nest building and egg laying starts (Drewien 1973). Pairs become aggressive toward their young of the previous year and proclaim their territory with loud, synchronized unison calls (Walkinshaw 1973). Pairs return to the same territory annually and both members assist in territorial defense. Pairs maintain mutually exclusive territories, and maximum aggressive behavior occurs during the pre-nesting period as adjacent pairs reestablish boundaries and drive off trespassing non-territorial cranes (Drewien 1973). The male is the most active in territory defense and females are less likely to retain the territory after loss of mates (Nesbitt and Tacha 1997).

Most habitat components are found within territories, including nest sites, food, roost sites, escape cover, and water. These components can be supplied by large marsh complexes (Drewien 1973); smaller, scattered marshes (Walkinshaw 1973, Armbruster 1987); bogs in northern boreal forests (Taylor 1976); intermittent streams in sagebrush parklands (Bieniasz 1979); and mountain meadows and beaver (*Castor canadensis*) ponds (Drewien 1973).

Sub-territories can partially or entirely cover pre-nesting, nesting, brood, and post-brood periods (Drewien 1973). RMP cranes at Grays Lake, Idaho, have the highest reported nesting density with a mean territory size of 17 ha (Drewien 1973). Isolation from human activity appears to be an important criterion for selection and use of nesting territories by cranes. Sandhill cranes have the propensity to desert their nests or territories due to human disturbances (Walkinshaw 1973, Drewien 1973, Boise 1976).

Nests may be established on dry-land sites with almost no nest material, but are more often in water on piles of emergent aquatic plants, sticks, grass, mud, and sphagnum (Lewis 1977). Nest size and complexity vary by location; those on dry sites are small and contain little material while those on water are larger and usually contain considerable nest material (Drewien 1973). At Grays Lake, RMP cranes nest from late April through early July (Drewien 1973).

Clutches usually contain two eggs; but occasionally may contain one or three eggs (Lewis 1977). Average clutch size is 1.9, but decreases in more northern-breeding birds (Nesbitt 1989, Tacha et al. 1994). Incubation begins after the first egg is laid (Drewien 1973, Lewis 1977). Both sexes share incubation duties during the day, but the female is the primary nest attendant at night (Drewien 1973, Nesbitt 1989). Nest success averages about 50%, but has been as high as 78% (Tacha et al. 1992, 1994; Drewien 1973). After 28–31 days of incubation, eggs hatch asynchronously (Drewien 1973, Lewis 1977). Sandhill cranes raise a single brood to fledging in a given year, but will renest following loss of eggs in northern nesting populations, or loss of eggs or young in southern populations (Tacha et al. 1994).

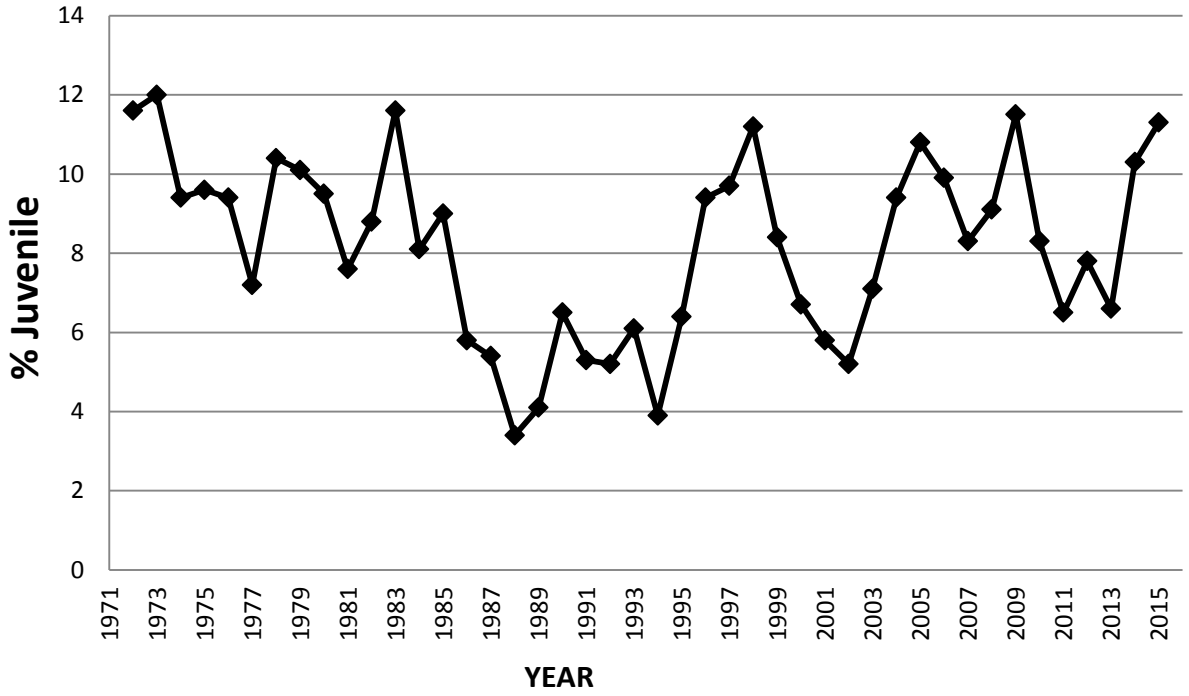

Figure 2. Recruitment (% juveniles) in the Rocky Mountain population of sandhill cranes, San Luis Valley, Colorado, 1972–2015.

Hatching takes 24 to 36 hours. The precocial colt is dry in a few hours and can walk the next day. After colts hatch, the family moves to open uplands or meadows for feeding. The family returns to the marsh each night to roost, often at the nest site or on platforms built by the parents (Lewis 1977). Both parents feed the young, but females do most post-hatch brooding (Tacha et al. 1994). During the preflight period, colts feed almost exclusively on animal matter, then transition to agricultural grains after fledging (Lewis 1977). The cranes fledge at 67–75 days with an average post-fledging brood size of 1.31 (range 1.21–1.35) at Grays Lake, Idaho (Drewien 1973). Young are usually independent at about 10 months of age (Drewien 1973, Drewien et al. 2001, Tacha et al. 1994).

Drewien (1973) found that nest success was 78% at Grays Lake NWR, ID. However, McWethy and Austin (2009) found at Grays Lake NWR, ID that nest success varied with habitat: apparent nest success for nests found in rushes was 0.86, sedges 0.75, mixed sedge willows 0.67, cattails 0.60 and willows 0.25. RMP sandhill crane clutches averaged 1.9 eggs (Drewein 1973). Cranes were capable of renesting when clutches were lost prior to mid-incubation. Mean brood sizes at hatching and fledging were 1.77 and 1.35, respectively.

Breeding Areas.—Typical nesting habitat occurs in river valleys, marshes, and wet meadows of northern Colorado, northern and central Utah, western and central Wyoming, southeastern and central Idaho, and central and western Montana, particularly in open country used for livestock where human populations are low. Increases in home development and subdivisions are negatively impacting some habitats in portions of eastern Idaho, western Wyoming, northern Utah, and southwestern Montana (Drewien and Thorpe 2005). Suitable, vacant crane habitat may be available in western Alberta and eastern Montana.

Migration Routes and Chronology

Fall.—In mid-August and September, cranes begin to arrive on pre-migration staging areas in Idaho, Wyoming, Utah, Montana, and Colorado (Drewien and Bizeau 1974, Drewien et al. 1995; Appendix A, Fig. 3). Most staging areas are attractive to cranes because of the availability of grain, mainly barley, located in close proximity to shallow lakes, marshes, and river bottoms used as roosting sites (Drewien and Bizeau 1974). Observations of marked cranes at staging areas suggest they generally move to the major pre-migration staging area nearest their summering site annually (Drewien and Bizeau 1974). Normally, crane numbers peak at specific staging areas in September, but timing varies somewhat by area and year. Most cranes leave pre-migration staging areas by late September and early October (Fig. 4).

Some staging areas (e.g., Star Valley and Bear River Valley, Wyoming), have become less suitable as land uses and agricultural practices have been altered. Increases in home development and subdivisions are negatively impacting some pre-migration staging habitats in portions of eastern Idaho, western Wyoming, and southwestern Montana (Drewien and Thorpe 2005).

The cranes continue south to the SLV, Colorado. It is the only major migratory staging area for RMP cranes, used by almost the entire population for extended periods each spring and fall

(Drewien and Bizeau 1974, Kauffeld 1982, Brown and Drewien 1995, Drewien et al. 1995, Benning et al. 1997). Peak use during fall occurs from late September to early November (ranging from late August to mid-December).

Roosting areas include the Monte Vista NWR Higel State Wildlife Area (SWA), Rio Grande SWA, the channel of the Rio Grande River, and private marshes and wet meadows along the river from the town of Monte Vista to the Alamosa NWR within the SLV. In fall, most cranes feed in private, harvested small-grain (wheat, barley, and triticale) fields (Drewien and Bizeau 1974; Kauffeld 1982; Drewien et al. 1995, 2001).

Many RMP cranes stop overnight or for several days at locations in western Colorado, northern New Mexico, and northeastern Utah. Sightings of color-marked cranes indicate many consistently use four locations in addition to the SLV, Colorado; (1) the Green River Valley between Jensen and Ouray NWR, Utah, (spring and fall), (2) Hart's Basin near Eckert, Colorado (spring) (Peterson and Drewien 1997); (3) Grand Valley, Colorado (near Grand Junction); and (4) northern New Mexico (Stahlecker 1992). Smaller numbers of migrating cranes stop at other localities, notably sites in the Gunnison and White River valleys, Colorado.

Wintering Areas.—Cranes begin to depart the SLV during late October and follow the Rio Grande River Valley south into the MRGV, New Mexico, southwestern New Mexico, southeastern Arizona, and northern Mexico (Drewien and Bizeau 1974; Fig. 1). Most RMP cranes terminate migration in Valencia and Socorro counties of the MRGV. Smaller numbers winter in southwestern New Mexico (Sierra, Grant, Dona Ana, and Luna counties) and Maxwell NWR, and the Sulphur Springs Valley in Cochise County, Arizona. About 10% continue into Chihuahua and Durango, Mexico, where they mix with more abundant lesser sandhill cranes (Drewien et al. 1996). Historically, the largest number of cranes wintered on Bosque del Apache NWR; however, since 2012, state Wildlife Management Areas (WMAs) and private lands have attracted more cranes, on average wintering 60% to over 80% of the cranes in the MRGV, probably due to changes in agricultural practices (Ashley Inslee, USFWS, Bosque del Apache NWR, unpublished data) (Appendix B).

On all winter areas, RMP cranes mix with other subspecies. In the MRGV, Gila River Valley, and the Pecos River Valley, MCP cranes comprise the majority of winter flocks. The proportion of lesser sandhill cranes wintering in the MRGV has increased in recent years. In other wintering areas, especially southwestern New Mexico, southeastern Arizona, and Mexico, smaller subspecies predominate. In 2012, the Arizona Game and Fish Department (AGFD) counted 34,459 cranes, in the Sulfur Springs Valley. Of those, 20–30% were estimated as RMP cranes. The total number of RMP cranes wintering in this area has increased markedly over the last 20 years, although the percentage comprised of RMP cranes has remained relatively constant. Some of this may be due to wetland drainage in Mexico (Drewien et al. 2003) and changes in agricultural crops from grain to cotton and chile in southwestern New Mexico (Mitchusson 2003). Current estimates of the number of wintering cranes vary between years in the MRGV (Appendix B). A portion of the RMP crane population are now beginning to spend the winter in northwest Colorado instead of migrating down to the MRGV (Gammonley, Colorado Division of Parks and Wildlife [CPW], personal communication).

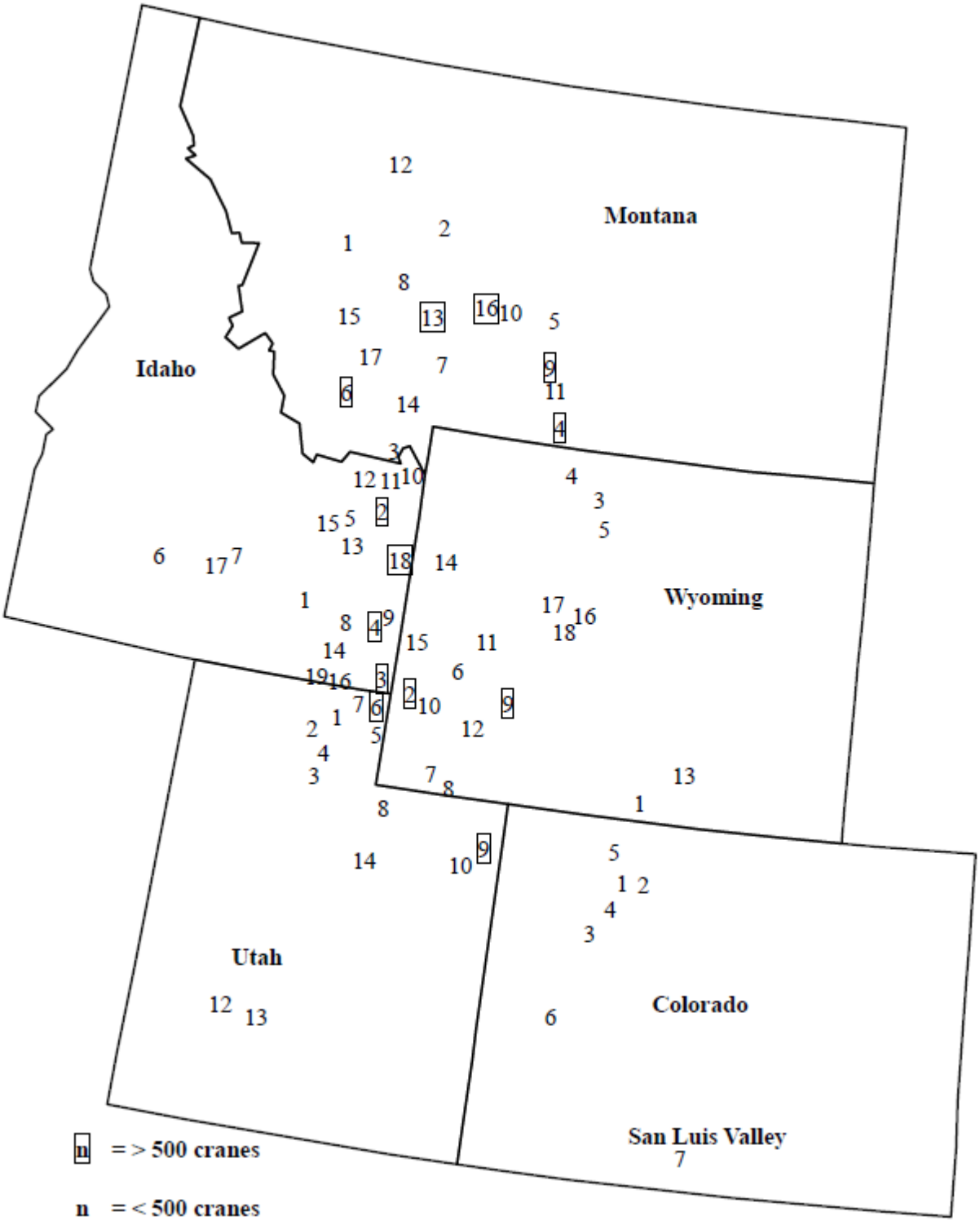

Figure 3. September survey locations for the Rocky Mountain Population of greater sandhill cranes (adapted from Thorpe et al. 2015; See Table 1 for location names and numbers).

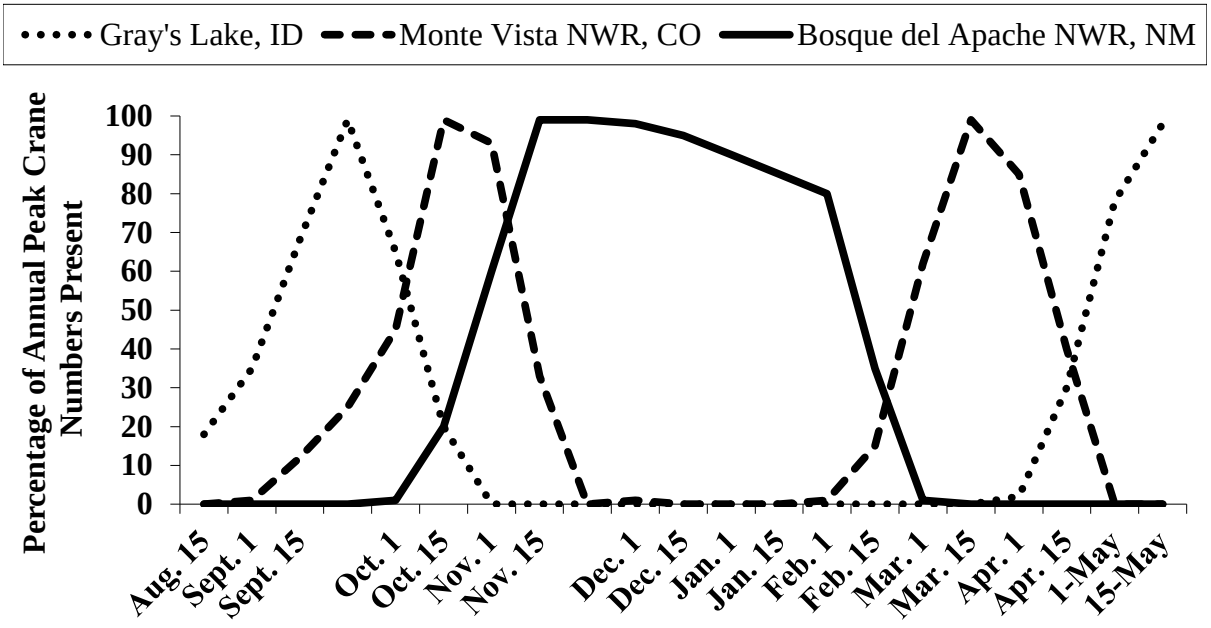

Figure 4. Migration chronology of Rocky Mountain Population greater sandhill cranes from breeding grounds to migration stopover and winter ranges and return (adapted from Drewien and Bizeau 1974).

Spring Migration Routes.—Migration from wintering areas begins as early as late-January or early February and follows the reverse pattern of fall movements (Drewien and Bizeau 1974, Drewien et al. 1999). RMP cranes return to the SLV where peak use occurs between mid-February and early April. The majority of crane use in spring occurs on the Alamosa and Monte Vista NWRs. A portion of small grains are not harvested in the fall, but left standing until spring to feed migrating cranes and other migratory birds when waste grain is in short supply elsewhere in the valley. After leaving the SLV, many cranes migrate to the Bear River Valley in portions of Idaho, Utah, and Wyoming, where they remain for a short period before returning to their breeding grounds (Drewien and Bizeau 1974).

Production and Mortality

Population Dynamics.—Sandhill cranes have the lowest known recruitment (percent juveniles in fall) of any avian species hunted in North America (Drewien et al. 1995). Nonbreeding cranes make up a relatively large proportion of the population, and for RMP cranes at Grays Lake, Idaho, they comprise 31–39 % of the total population annually (Drewien 1973).

Factors such as availability of food and water, weather, and predation on the breeding grounds appear to primarily influence brood size (Drewien et al. 1995). During 2015, fall recruitment in RMP cranes was estimated at 11.3% with a mean brood size of 1.18 (Fig. 2; Brown 2015). About 20% of the RMP crane recruitment comes from those nesting pairs that have two or sometimes three young in their broods (Drewien et al. 1995).

Adult cranes are long-lived, but mortality on eggs and young colts can be high. Crows (*Corvus brachyrrhynchos*) and striped skunks (*Mephitis mephitis*) are primarily egg predators while ravens (*Corvus corax*), raccoons (*Procyon lotor*), and coyotes (*Canis latrans*) prey on eggs and young birds (Armbruster 1987, Littlefield and Thompson 1987, Littlefield and Lindstedt 1992). Golden eagles (*Aquila chrysaetos*) also attack and kill cranes (Armbruster 1987, Drewien et al. 2001, Mitchusson 2003).

Estimated annual survival for RMP cranes from 1972–1985 was 95% (Drewien et al. 1995). With expanded hunting throughout the RMP range, current annual RMP crane adult survival is estimated at 89% (W. Kendall, USGS Colorado State University Cooperative Research Unit, personal communication). Most (>70%) mortality is due to human causes. Legal and illegal shooting accounts for 58.3%, with hunting (53.9%) being the single most important mortality factor. Other non-shooting mortality factors were by unknown causes (24.4%), power-line and fence collisions or entanglements (10.0%), and other factors (7.3%). The proportion of cranes lost to shooting increases with age, whereas non-shooting mortality declines with age, which suggests older cranes learn to avoid many forms of non-shooting mortality (Drewien et al. 2001).

Diseases such as avian botulism (*Clostridium botulinum*) and avian cholera (*Pasteurella* spp.) are leading causes of non-shooting mortality (Windingstad 1988, Tacha et al. 1994). Avian tuberculosis (*Mycobacterium avium*), aspergillosis (*Aspergillus* spp.), ingestions of mycotoxins, and lead poisoning are other causes of nonshooting mortality (Windingstad

1988; Tacha et al. 1992, 1994). Hail storms and lightning are notable, but localized, environmental causes of crane mortality (Windingstad 1988).

Since the 1980s, incidences of avian cholera and avian tuberculosis in cranes have increased in the MRGV, and have been associated with increases in winter populations of lesser snow geese (*Chen caerulescens*) and Ross's geese (*Chen rossii*; Snyder et al. 1987, Taylor and Kirby 1990, Drewien et al. 2001). Lesser snow geese and Ross's geese are carriers of avian cholera (Samuel et al. 2005) and often mix with sandhill cranes on winter and migration areas. Outbreaks of avian cholera in cranes at Bosque del Apache NWR have occurred in nine winters during 1984–1999, including a peak loss of 110 cranes in 1993–1994 (Drewien et al. 2001).

Public Use

Harvest.—Regulated hunting of RMP cranes occurs in Arizona, Idaho, Montana, New Mexico, Utah, and Wyoming (Table 3 and Appendix A). In Mexico, subsistence and recreational hunters also pursue cranes, but their take of RMP cranes is unknown. Recreational hunting is allowed only in registered UMAs (Unidad de Manejo para la Conservacion de Vida Silvestre – Management Unit for the Conservation of Wildlife). Any state within the range of the RMP may choose to hunt cranes provided the hunts meet the conditions of this plan. Harvest of RMP cranes varies annually based on the status of the population and recruitment, and in some years has exceeded 1,000 birds. The highest recorded harvest was 1,392 birds in 2009; 2014 harvest was 624 (Table 4). The average U.S. harvest for the period since all states within the range of RMP cranes began hunting them except Colorado (1998–2014) was 792 birds (data from Kruse and Dubovsky 2015). Hunting of RMP cranes can help mitigate, and in some cases prevent, crop damage in areas where cranes concentrate. These crops are often near fall pre-migration staging and stopover areas and selected wintering areas. Hunting in these areas directs harvest at cranes that damage crops.

The allowable harvest of RMP cranes is calculated annually and the realized harvest is monitored using a permit system. The methods used to set harvest levels are discussed in more detail in the management section.

Nonconsumptive Use.—Sandhill cranes are impressive in areas of concentration and are of special interest to the general public. Throughout their range "crane festivals" are attended by thousands of watchers, photographers, and bird lovers annually at several important staging and wintering locations. These locations include Socorro, New Mexico; Willcox, Arizona; and Monte Vista, Colorado. Gatherings of people and cranes provide a venue to promote awareness and understanding of RMP cranes and plays a part in crane conservation. Individual state wildlife agencies and the FWS have cooperatively developed and distributed information on the life history of RMP cranes and important management issues.

Table 1. Staging areas to be surveyed annually during the September pre-migration survey.

Colorado	Idaho	Montana	Utah	Wyoming
Yampa Valley	American Falls Reservoir	Blackfoot/Ovando Valley	Cache County	Baggs
Lower Elk River	Ashton-St. Anthony	Cascade-Ulm	Box Elder County	Bear River Valley
White River	Bear River Valley	Centennial Valley	Davis County	Greybull River/Otto
Williams Fork River	Blackfoot Reservoir	Clark Fork of the Yellowstone	Weber County	Shoshone River/Ralston
Little Snake River	Camas NWR	Deadman's Basin	Morgan County	Worland
Delta County	Camas Prairie	Dillon-Twin Bridges	Bear River Valley	Big Piney-Daniel
San Luis Valley	Carey Lake area	Gallatin Valley	Round Valley	Bridger Valley
	Chesterfield Reservoir	Helena Valley	Summit County	Lonetree
	Grays Lake NWR	Melville	Jensen	Farson
	Henry's Lake Flats	Musselshell River	Pelican Lake area	Hams Fork
	Island Park Reservoir	Otter Creek	Leland Bench	Pinedale-Cora-Boulder
	Kilgore	Teton River-Eureka Reservoir	Wasatch County	Seedskadee NWR
	Market Lake WMA	Toston-Townsend		Saratoga
	Marsh Valley	Upper Madison Valley		Jackson Hole
	Mud Lake WMA	Warm Springs		Star Valley
	Oxford Slough-Swan Lake	White Sulphur Springs		Hidden Valley
	Silver Lake	Whitehall		Ocean Lake
	Teton Basin			Riverview Valley
	Malad River			Barnum
				Mayoworth
				Sussex
				Buffalo
				33 Mile
				Dayton

Table 2. Annual Rocky Mountain Population sandhill crane allowable and retrieved harvest.

		Retrieved Harvest						
Year	Allowable Harvest[1]	AZ	ID	MT	NM	UT	WY	Total
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		40			310		128	478
1989	800	51			483	54	125	713
1990	374	9			79	35	58	181
1991	800	44			47	48	101	240
1992	800	39		42	147		168	396
1993	780	61		45	297	28	115	546
1994	864	27		40	416	34	150	667
1995	547	33		41	270	27	77	448
1996	545	27	20	49	236	32	84	448
1997	632	22	136	62	114	30	82	446
1998	693	37	135	59	180	34	93	538
1999	974	21	190	71	198	54	124	658
2000	1,141	37	193	91	257	69	163	810
2001	1,175	26	278	87	288	77	142	898
2002	833	42	194	51	160	60	132	639
2003	668	34	146	50	169	57	72	528
2004	656	35	142	51	189	53	124	594
2005	906	50	189	49	236	62	116	702
2006	1,321	10	235	54	327	87	194	907
2007	1,320	43	187	73	276	103	138	820
2008	1,714	24	185	85	379	101	162	936
2009	1,940	67	254	124	603	149	195	1,392
2010	1,985	56	253	108	547	190	182	1,336
2011	1,777	37	293	90	522	154	166	1,262
2012	1,270	85	275	129	417	91	134	1,131
2013	771	38	135	94	241	96	74	678
2014	676	20	134	121	183	72	94	624

[1] Includes Mexico's portion.

MANAGEMENT ISSUES

Crop Damage

Increases in densities of RMP cranes, whether produced by normal recruitment or forced concentrations of birds due to shrinking habitats, contribute to increases in damage to private agricultural crops. Although cranes are known to eat a variety of crops, invertebrates, and even small mammals, crop damage has been described as either consuming the fruit or plant (or seed) in early stages of germination. Damage to un-harvested cereal grain crops can be significant, especially in the vicinity of the higher-elevation pre-migration staging areas where harvest is often delayed until September. Some of these problems are alleviated by habitat improvement projects on state and federal lands and through carefully-designed and regulated sport hunting programs in the U.S portion of the RMP range.

Habitat Destruction, Degradation, and Manipulation

Issues affecting RMP crane habitat vary among regions. The various seasonal habitats continue to be impacted from a variety of causes, including housing and industrial developments, changing agricultural practices (e.g., converting small grain crops to other commodities like cotton or alfalfa), overgrazing by livestock, oil and gas exploration and development, drought, flood control projects, water diversions, water pollution, and wetland drainage. Hazards, such as transmission lines and even stock fences, contribute to annual mortality.

Habitat Improvement

State agencies continue to work with other land-management agencies and private landowners to improve nesting habitat. Habitat projects have focused on acquiring and manipulating land to provide food (corn and sorghum) and roosting areas for cranes, some of which are accomplished by actively pumping water to traditionally dry areas.

Wetland management most often includes pumping and irrigating to provide foraging and loafing sites, and open water for roosting sites Increasing water conflicts between urban, agricultural, interstate stream compacts, and endangered species management (e.g., the silvery minnow [*Hybognathus amarus*]), especially during drought periods, can also adversely impact crane habitats. Without the regular high flows to scour river vegetation, roost sites become overgrown, concentrating birds into fewer open areas.

Disease

Shrinking habitats in fall staging and wintering areas, particularly roosting areas, increase the risk of disease outbreaks due to overcrowding of birds. Avian tuberculosis, cholera, botulism, and lead poisoning have also caused crane mortality in wintering areas.

Specific State Issues

Arizona.— The planned placement of a high tension powerline next to the Willcox Playa could have potential impact on a crane roosting site. There are shifts from grains, corn, and sorghum towards alfalfa and cotton. Cranes consume alfalfa only when the plants are small; cotton is of no value to cranes. Arizona has implemented a cooperative agreement with several local farmers to grow corn and leave waste grain for cranes. There remains a concern that should agricultural practices change, forage availability could become a problem in the future. Under current conditions, roosting habitat is secure, but food availability may limit population size.

Botulism is potentially a problem on Willcox Playa, the major roost area. A minor outbreak occurred in 1980. The AGFD has attempted to mitigate this problem with additional roost areas at Crane Lake (within Wilcox Playa itself) and Whitewater Draw.

Colorado.— The lowering of the water table in the SLV has resulted in loss of foraging wetlands, forcing cranes to become primarily dependent on grain crops for nutrition. Fall tilling and irrigation of harvested small grain fields in the SLV has reduced the supply of grain available in the spring for cranes and waterfowl. Additional food sources may be developed to maintain body condition and reproductive potential of cranes returning to nesting areas.

Idaho.—A major segment of the RMP nests in eastern Idaho and nearly 30% of the population stages there in September. As such, grain and potato farmers often express concern of damage caused by cranes during this time period. Some operators claim they cannot afford the loss in revenue resulting from cranes feeding on their crops. On numerous occasions, they have requested relief from the Idaho Department of Fish and Game and the Idaho Congressional delegation. In the early 2000s, a lure crop program was implemented in Caribou County to issue annual payments to farmers who provide foraging areas to staging cranes. The implementation of hunting seasons and the lure crop program has improved farmer tolerance for cranes in this area. Urban development in Teton Basin, Teton County, is removing habitat traditionally used by RMP cranes; consequently, capacity to support summering and staging cranes has been reduced, while potential for crop damage complaints has increased. Efforts to document and protect important crane use areas in Teton Basin are ongoing. In addition, crane use of the Grays Lake NWR has declined over the past 20–25 years because of changes in habitat management. This decline is concurrent with increased crop damage problems in the Blackfoot Reservoir area since the 1990s.

Mexico.—Additional information for this section should be solicited from Secretaria de Medio Ambiente y Recursos Naturales. Crop damage during the winter period may be a problem. Though potential excessive subsistence and recreational harvests of cranes is unlikely, better harvest information is desirable. The loss of wetland habitats is likely to continue and increase from a variety of land developments. Principle causes of wetland degradation throughout Mexico include water diversions, pollution, deforestation, overgrazing, and other effects associated with human population growth (Drewien et al. 1996, 2003). The greatest threat could be the proposal by the Mexican government to drain much of the Babicora Basin in west-central Chihuahua, the most important crane wintering location in Mexico. Babicora Basin's importance is greatest for the lesser subspecies. However, loss of this wetland would eliminate potential use by RMP cranes. The Galeana area in northwest Chihuahua was formerly an

important RMP winter area during the 1970s–1990s (Drewien et al. 1996). The primary roosting wetland was recently drained, resulting in greatly reduced crane use of this winter site.

Montana.—Damage to unharvested cereal grain crops can be significant, especially in the vicinity of the higher-elevation pre-migration staging areas where harvest is often delayed until September. Breeding areas, especially in Intermountain valleys, are experiencing increased urbanization and subdivision encroachment. This results in additional power lines and greater potential for aerial collisions.

New Mexico.—Increased urbanization, changes in agricultural crops, and water management have negatively impacted sandhill crane habitat. Urban development in portions of the MRGV from Los Lunas to San Antonio has eliminated many winter sites and more will be lost in the near future. In 2006, an important agricultural winter site near Los Lunas was sold and is being converted to housing. This property supported up to 1,000 cranes and 7,100 geese. As habitat is lost, wintering cranes and waterfowl are restricted to fewer areas. Food supply and overcrowding are becoming priority concerns for population maintenance. However, the city of Albuquerque's Open Space Division currently manages nearly 200 acres of food production for cranes and waterfowl. Houses built on the MRGV floodplain now prevent the very large spring flows necessary to scour the riverbed and alter the river channel to maintain suitable unvegetated roost sites. As lands are converted from agricultural uses to urban areas, more hazards for sandhill cranes in the form of power lines and fences will be created. Currently, urbanization does not pose a large threat to the other wintering areas, but there is the potential conflict as agricultural lands and water supplies are diverted from agricultural practices to urban uses.

Periodically depredations by cranes have been severe in Valencia, Socorro, Sierra, Dona Ana, and Luna counties. As habitat is lost and wintering waterfowl and cranes are restricted to fewer areas, food supply and overcrowding are becoming priority concerns for population maintenance. Changes in crop patterns in most locations has reduced feeding habitat (less grain and more alfalfa, cotton, and chile).

Utah.—Urban expansion along the Wasatch Front and Cache and Summit counties continues to consume natural and agricultural habitats important to breeding and staging crane populations. Depredations on remaining agricultural areas are consequently growing in some areas and reduced tolerance for cranes can be problematic.

Wyoming.—RMP cranes will stage near several agricultural projects in central and western Wyoming during late summer to early fall, where crop damage can be a problem. The damage is often compounded by feeding activities of RMP Canada geese that also congregate in the same areas. Controlled hunts in September effectively disperse cranes and geese from grain fields. However, new damage situations occasionally arise as agricultural practices change and crane distribution shifts.

Agricultural interests have voiced concern about fall crop damage by RMP cranes in all hunt areas. Recently, these interests have voiced concern about spring and fall crop damage on the east and south sides of the Big Horn Mountains. Food resources in pre-migration staging areas are limited and therefore crop depredations occur. Expansion of barley production in the Farson-

Eden area the last seven years has not resulted in an increase in crop damage by cranes and geese. Staging by several hundred to a thousand cranes along the Greybull and Shoshone rivers in Park and Big Horn counties is a fairly recent development, which has caused some crop damage complaints in that region. During the last decade, the Boysen-Riverton area had the highest number of crop depredation complaints. Except on the Ocean Lake Habitat Unit, the WGFD does not plant supplemental feed to attract cranes or geese away from private grain fields. Farm operators continue to request additional permits and longer seasons to alleviate crop damage. Damage to newly planted row crops in the spring is a more difficult issue, which cannot be addressed by controlled hunting seasons.

Valley floor and floodplain development throughout Wyoming seriously threatens many of the State's most limited and important wildlife habitats. Ongoing development in the Star Valley has impacted preferred crane roost sites. The explosion of subdivisions in the lower Star Valley has reached the point where an aerial survey is no longer flown. Numbers of cranes using this area have declined substantially in recent years (Thorpe et al. 2015; Table 1).

RECOMMENDED MANAGEMENT STRATEGIES

The following management strategies are recommended and considered priorities. The degree and timing of their implementation by various lead agencies will be influenced by manpower and fiscal and legislative constraints beyond the scope of this plan. Whenever possible and appropriate, plans for other species and populations of Pacific and Central Flyway birds should also consider the management procedures in this plan. Improved coordination between state and federal refuges throughout the region would greatly enhance sandhill crane management.

Habitat

1. Maintain and enhance crane habitat on private, state, and federal land, including wildlife refuges, by providing foraging sites and sufficient loafing and roosting sites. Feeding sites should include native food items and agricultural grains.

    a. Identify important breeding, staging and wintering areas, including roosting, loafing, and feeding sites to provide and protect habitat on public and private lands.

        Lead agencies: FWS, State Wildlife Agencies, Natural Resource Conservation Service (NRCS)
        Schedule: Ongoing

    b. Work with state, federal, and private land managers to ensure sufficient forage is available to migrating and overwintering cranes.

        Lead agencies: FWS, State Wildlife Agencies
        Schedule: Ongoing

    c. Manage wetlands and uplands to reduce dependency on small grains.

        Lead agencies: FWS, State Wildlife Agencies, NRCS, Bureau of Land Management (BLM), U.S. Forest Service (USFS)
        Schedule: Ongoing

    d. Lead agencies will be responsible for identifying habitat presently important to cranes and locating willing sellers or those willing to enter into cooperative agreements to protect these lands.

        Lead agencies: FWS, State Wildlife Agencies, NRCS, BLM, USFS
        Schedule: Ongoing

2. Identify and reduce environmental and man-made hazards that cause crane mortality.

    a. Work with local utility companies when locating new power lines and encourage them to mark new and existing power lines, bury lines, or locate lines away from high use areas to reduce lethal crane strikes.

Lead agencies: FWS, State Wildlife Agencies
Schedule: Ongoing

Harvest

1. Maintain hunting regulations that meet the objectives of this plan. Hunting will be allowed when the 3-year average of the fall population index exceeds 15,000. If the 3-year average of the fall population index is less than 15,000, hunting may be permitted to meet specific management objectives, including alleviation of localized crop damage and distribution concerns.

   Because portions of the RMP range overlap with other subspecies, states hunting mixed populations will estimate the racial composition of the hunted population once every three years in operational hunt areas. States that hunt mixed populations (NM and AZ) are required to estimate harvested subspecies composition through measuring the length of wing chord, tarsus, and posterior nares to bill tip of harvested cranes (Schmitt and Hale 1997) or other appropriate methods. Only estimated RMP harvest will be included in the allowable harvest allocation. States that consider all harvested cranes in a hunt area as RMP cranes are not required to monitor racial composition.

2. The total allowable harvest for the population will be based on the formula:

   $H = C \times P \times R \times L \times f$ where:

   H = total allowable harvest for the population
   C = the average of the three most recent, reliable fall population indices
   P = the average proportion of fledged chicks in the fall population in the SLV during the most recent three years for which data are available
   R = estimated recruitment of fledged chicks to breeding age (0.5)
   L = retrieval rate of 0.80 (allowance for an estimated 20% crippling loss)
   f = (C/16,000)3 (a variable factor used to adjust the total harvest to achieve a desired effect on the entire population.

   When results of the RMP crane fall population survey and recruitment survey are available each year (by 1 December), the FWS Pacific Flyway Representative will use the available data and the harvest formula to calculate the overall allowable harvest and the state harvest allocations for the subsequent hunting season. The Pacific Flyway Representative will share the resultant allowable harvest and harvest allocation results with the FWS Central Flyway Representative, and each representative will pass this information to the appropriate technical committee of the Pacific and Central Flyway councils by early February. The Pacific Flyway Representative also will notify the FWS Regulations Specialist of the resultant allowable harvest allocations to be published in the Federal Register with the final rule on migratory bird hunting season frameworks.

The allowable harvest will be allocated among states based on RMP crane distribution and relative abundance. Specifically, 55% of the annual allowable harvest will be allocated to summer range states and 45% will be allocated to winter range and migration stopover states. Summer range states include Alberta, Idaho, Montana, Wyoming, Utah, and Colorado. Winter range and migration stopover states include Utah, Colorado, New Mexico, Arizona, and Mexico. The allowable harvest will be further allocated among summer range and winter range and migration stopover states based on the relative abundance of cranes among states within each seasonal range. For summer range states, a 5-year moving average of the most recent reliable estimates (e.g., 2016 season determination using data during 2011–2015) from the September survey will be used to determine the proportion of the population in each state, and this will be used accordingly to allocate 55% of the allowable harvest. For winter range and migration stopover states, a fixed value for the proportion of the population in each state will be used accordingly to allocate 45% of the allowable harvest. The fixed values for the winter range and migration stopover states are 62% for New Mexico, 13% for Arizona, 13% for Colorado, 6% for Utah, and 6% for Mexico.

Any summer range allocation not used by a state will be made available to other summer range states. However, Colorado's unused summer portion will be allocated to wintering states. Any winter range and migration stopover allocation not used by a state will be made available to other winter range and migration stopover states. Unused birds (e.g.; Colorado) will be reapportioned to either summer or winter range states based on each states percentage of birds as above.

3. A state proposing a new hunt in an area not hunted before must present the subcommittees at least three consecutive years of data (i.e., the most recent three years) on RMP numbers in the proposed hunt area. The state must also commit to continued monitoring. The state must notify the subcommittees, Pacific Flyway Study Committee, and Central Flyway Webless Migratory Game Bird Technical Committee (CFWMGBTC) in writing of its intentions at least 30 days prior to the subcommittees' meetings.

4. The following information must be collected and reported to the subcommittees at the appropriate meeting following each hunt:

    a. Number of cranes harvested
    b. Racial composition of the harvest (if applicable)
    c. Age composition of the harvest
    d. Crippling-loss rates
    e. Number of hunters participating
    f. Number of hunter days
    g. Hunter success rate
    h. An assessment of the effectiveness of the hunting season

5. Hunting will be permitted in the states of Arizona, Colorado, Idaho, Montana, New Mexico, Utah, and Wyoming. State hunting seasons must:

a. Be between 1 September and 31 January
b. Have a daily bag limit not to exceed three cranes
c. Be permitted only on a limited quota (permit) basis
d. Be consistent with the goals and objectives outlined in this plan
e. Be approved by both the Central and Pacific Flyway councils

6. A state requesting a new hunting area or changes to an existing hunting area, must notify the subcommittees, Pacific Flyway Study Committee, and Central Flyway Webless Migratory Game Bird Technical Committee (CFWMGBTC) in writing of its intentions at least 30 days prior to the subcommittees' meetings.

Crop Damage Control

1. Use recreational hunting to regulate crane numbers and minimize fall depredation to private croplands.

    a. Hunting should be used to redistribute cranes from areas of depredation concern.
    b. Hunting to control specific damage problems will be allowed even when the 3 year average of the fall population index is below 15,000 birds; these hunts must be designed to relieve a specific problem and where necessary, coordinated among the states for effective dispersal.

        Lead agencies: FWS, State Agencies, Pacific, and Central Flyway councils
        Schedule: Annually

2. Providing supplemental feed via either strategically located crops planted specifically to provide food for cranes or direct placement of grain, in conjunction with or without hunting seasons, can be used to reduce crop damage. State and federal refuges can have a major role towards increasing grain crops for crane use. These programs are most effective when used in conjunction with hunting seasons or hazing.

    Lead agencies: FWS, State Agencies, NRCS,
    Schedule: Annually

3. Use aircraft, explosive devices, or other deterrents to move birds from croplands and adjacent roost sites.

    Lead agencies: State Agencies, Wildlife Services
    Schedule: Annually

4. In certain situations, it may be possible to encourage landowners to change farming practices to reduce the attractiveness of crops to cranes, eliminate roosts, or make crop plantings available for cranes near roosts.

    Lead agencies: FWS, State Agencies, NRCS
    Schedule: Annually

5. State and federal agencies, in cooperation with key stakeholders, may find it beneficial to provide field demonstrations of methods available to reduce crop damage by cranes.

    Lead agencies: FWS, State Agencies, NRCS
    Schedule: Annually

Population Surveys

1. Conduct a fall population survey each September when peak numbers of cranes are present on pre-migration staging areas in summer range states. The average of the three most recent, reliable surveys, described in Objective 1, will be used in the harvest allocation formula. The survey team (pilot and observers) will provide insight into the reliability of the estimate based on survey timing, survey coverage, and weather conditions. If the count is judged to be poor, it will be excluded from the average and the most recent 3 reliable surveys will be used to determine the average.

    a. The September survey will be conducted from the air and ground, as appropriate, during a consecutive 5-day period between 5–25 September each year. An effort will be made to complete the count during three consecutive days within the 5-day period. If conditions prevent a state cooperator from meeting this schedule, counts must be completed as soon thereafter as conditions permit. State cooperators will forward results of any surveys they conduct to the FWS Flyway biologist by 30 September each year. FWS biologist will report to the FWS Pacific and Central Flyway Representatives and the appropriate technical committee of the Pacific and Central Flyway Councils by 1 December each year.

    b. If an aerial or ground survey location has been void of cranes for a period of three or more years, that area may be removed from the survey. If a new area is found to contain cranes by ground or aerial survey crews, those cranes will be added to the total, but the area will need to be surveyed for three years by a ground crew before being considered to be added to the official aerial fall survey.

    c. The costs of the fall pre-migration survey are shared among the FWS and states with RMP cranes. The FWS pays for an airplane and one pilot. States with assigned coverage areas during the fall pre-migration staging counts pay for their own personnel and equipment costs to complete the surveys.

        Lead agencies: FWS and all states with breeding cranes
        Schedule: Annually

2. Conduct an annual recruitment survey, where an index to recruitment (percent juveniles) is obtained each October in the SLV using methods described by Drewien (2005). A consultant will be retained by the Pacific Flyway Council to conduct the October recruitment survey and data compilation. The consultant's costs are negotiated periodically and paid by the Pacific Flyway Council. A report of results will be provided to the FWS Pacific and Central Flyway Representatives and the appropriate technical committee of the Pacific and Central Flyway Councils by 1 December each year.

Lead agencies: Pacific Flyway Council, FWS
Schedule: Annually

Research

1. Investigate if agricultural food resources are limiting RMP crane numbers and how different agricultural practices affect the amount of waste grain available to RMP cranes.

   Lead agencies: RMP Crane Subcommittees
   Participating: FWS, Monte Vista NWR, CPW, academic institutions, and consultants with applicable expertise
   Schedule: Continuing

2. Investigate if natural food resources are limiting RMP crane numbers and investigate methods of increasing natural food resources by improving and increasing wetland habitat.

   Lead agencies: RMP Crane Subcommittees.
   Participating: FWS, academic institutions, and consultants with applicable expertise
   Schedule: Continuing

3. Refine the method of collecting adult and juvenile survival estimates.

   Lead agencies: RMP Crane Subcommittees.
   Participating: FWS, academic institutions, and consultants with applicable expertise
   Schedule: Continuing

4. Develop a more accurate recruitment estimate.

   Lead agencies: RMP Crane Subcommittees.
   Participating: FWS, academic institutions, and consultants with applicable expertise
   Schedule: Continuing

5. Investigate the biological justification for managing western populations of greater sandhill cranes collectively.

ANNUAL REVIEW OF PLAN AND REPORTING

The Subcommittees will meet annually or as needed to review progress toward achieving the goals and objectives of this plan and to recommend revisions to the Pacific Flyway Study Committee and the CFWMGBTC. The CFWMGBTC and the Pacific Flyway Study Committee will submit all proposed revisions to this management plan to both the Central and Pacific Flyway councils for approval. As appropriate, the Subcommittees will also report on accomplishments and shortcomings of its cooperative management efforts to both councils, those state and federal agencies having management responsibilities, and those agencies and organizations either interested or cooperating in the management of cranes.

LITERATURE CITED

Armbruster, M. J. 1987. Habitat suitability index models: greater sandhill crane. U.S. Fish and Wildlife Service Biological Report 82 (10.140). 26 pp.

Ballard, B. M., J. E. Thompson, M. T. Merendino, J. D. Ray, J. A. Roberson, and T. C. Tacha. 1997. Demographics of the Gulf Coast subpopulation of Mid-continent sandhill cranes. Paper presented at the 4th Annual Conference of The Wildlife Society. Snowmass Village, CO, Sept 21–27, 1997.

Benning, D. S., R. C. Drewien, D. H. Johnson, W. M. Brown, and E. L. Boeker. 1997. Spring population estimates of Rocky Mountain greater sandhill cranes in Colorado. Proceedings North American Crane Workshop 7:165–172.

Bieniasz, K. A. 1979. The greater sandhill crane in Routt County, Colorado, pp. 197–203 *in* J.C. Lewis, editor. Proceedings 1978 Crane Workshop. Colorado State University Printing Service, Ft. Collins, CO.

Boise, C. M. 1976. Breeding biology of the lesser sandhill crane *Grus canadensis canadensis* (L.) on the Yukon-Kuskokwim Delta, Alaska. M.S. thesis. University of Alaska, Fairbanks, AK. 79 pp.

Braun, C. E., R. C. Drewien, C. D. Littlefield, and L. H. Walkinshaw. 1975. Conservation committee on status of sandhill cranes. Wilson Bulletin 87(2):297–302.

Brown, W. M. 2014. October 2014 Recruitment survey of the Rocky Mountain population of greater sandhill cranes. Special Report in the files of the Central Flyway Representative, Denver, CO. 2 pp.

Brown, W. M., and R. C. Drewien. 1995. Evaluation of two powerline markers to reduce crane and waterfowl collision mortality. Wildlife Society Bulletin 23:217–227.

Case, D. J., and S. J. Sanders. 2009. Priority Information Needs for Sandhill Cranes: A Funding Strategy. Association of Fish and Wildlife Agencies' Migratory Shore and Upland Game Bird Support Task Force. 13 pp.

Collins, D.P., B.A. Grisham, C. M. Conring, J.M. Knetter, W. C. Conway, S.A. Carleton, M.A. Boggie. 2015. Evidence of new summer areas and interpopulation mixing of two Greater Sandhill Crane Populations in the Intermountain West. Journal of Fish and Wildlife Management ?? 25pp.

Donnelly, J. P., and J. L. Vest. 2014. Greater Sandhill Crane Habitat Initiative: Meeting the information needs for a landscape conservation strategy. Intermountain West Joint Venture Technical Series 2014-1, Intermountain West Joint Venture, Missoula, MT.

Drewien, R. C. 1973. Ecology of Rocky Mountain greater sandhill cranes. Ph.D. Thesis. University of Idaho, Moscow. 152 pp.

Drewien, R. C. 2005. October 2005 Recruitment survey of the Rocky Mountain population of greater sandhill cranes. Special Report in the files of the Central Flyway Representative. Denver, CO. 2 pp.

Drewien, R. C., and E. G. Bizeau. 1974. Status and distribution of greater sandhill cranes in the Rocky Mountains. Journal of Wildlife Management 38:720–742.

Drewien, R. C., and P. P Thorpe. 2005. September 2005 survey of the Rocky Mountain population of the greater sandhill cranes. Special Report in the files of the Central Flyway Representative. Denver, CO. 8 pp.

Drewien, R. C., W. M. Brown, and D. S. Benning. 1996. Distribution and abundance of sandhill cranes in Mexico. Journal of Wildlife Management 60(2):270–285.

Drewien, R. C., W. M. Brown, and W. L. Kendall. 1995. Recruitment in Rocky Mountain greater sandhill cranes and comparisons with other populations. Journal of Wildlife Management 59(2):339–356.

Drewien, R. C., A. Lafón, J. P. Taylor, J. M. Ochoa B., and R. E. Shea. 2003. Status of lesser snow geese and Ross's geese wintering in the Interior Highlands of Mexico. Wildlife Society Bulletin 31:417–432.

Drewien, R. C., W. M. Brown, D. C. Lockman, W. L. Kendall, K. R. Clegg, V. K. Graham, S. S. Manes. 2001. Band recoveries, mortality factors, and survival of Rocky Mountain greater sandhill cranes. Unpublished report, Hornocker Wildlife Institute, Bozeman, MT. (on file, DMBM office, UWFWS, Denver, CO).

Kauffeld, J. D. 1982. Management of migratory crane habitat on Alamosa and Monte Vista National Wildlife Refuges. Pages 117–121 *in* J. C. Lewis, ed. Proceedings 1981 Crane Workshop, National Audubon Society, Tavernier, FL.

Kruse, K. L., and J. A. Dubovsky. 2015. Status and harvests of sandhill cranes: Mid-continent, Rocky Mountain, Lower Colorado River Valley and Eastern Populations. Administrative Report, U.S. Fish and Wildlife Service, Lakewood, Colorado. 14 pp. plus tables and figures.

Lafón A., and D. M. Soto. 1989. Evaluacion del aprovechamiento cinegético en el estado de Chihuahua. Reporte Final NAWCA-SEDUE-U.S. F&WS.

Lewis, J. C., Chairman. 1977. Sandhill crane. Pages 4–53 *in* G. C. Sanderson, editor. Management of migratory shore and upland game birds in North America. International Association of Fish and Wildlife Agencies, Washington, D.C.

Littlefield, C. D., and S. M. Lindstedt. 1992. Survival of juvenile greater sandhill cranes at Malheur National Wildlife Refuge, OR. Pages 21–31 *in* D. A. Wood, editor. Proceedings 1988 North American Crane workshop. Florida Game Fresh Water Fish Commission. Nongame Wildlife Program Technical Report 12. Tallahassee, FL.

Littlefield, C. D., and S. P. Thompson. 1987. Distribution and status of the Central Valley Population of greater sandhill cranes. Pages 113–120 *in* J. C. Lewis, editor. Proceedings 1978 Crane Workshop. Colorado State University Printing Service, Fort Collins, CO.

Lockman, D. C., L. Serdiuk, and R. C. Drewien. 1987. An experimental greater sandhill crane and Canada goose hunt in Wyoming. Pages 47–57 *in* J. C. Lewis and J. W. Ziewitz, editors. Proceedings 1985 Crane Workshop. The Platte River Whooping Crane Trust and U.S. Fish and Wildlife Service, Grand Island, NE.

Meine, C. D., and G. W. Archibald, editors. 1996. The cranes: - Status survey and conservation action plan. IUCN, Gland, Switzerland, and Cambridge, U.K. 294 pp. University of Chicago, Chicago, IL.

Mitchusson, T. 2003. Long-range plan for the management of sandhill cranes in New Mexico 2003–2007. Federal Aid in Wildlife Restoration Grant W-139-R-1, Project 08.01 Santa Fe (NM), New Mexico Department of Game and Fish, 46 pp.

Nesbitt, S. A. 1989. The significance of mate loss in Florida sandhill cranes. Wilson Bulletin 101:648–651.

Nesbitt, S. A., and T. C. Tacha 1997. Monogamy and productivity in sandhill cranes. Proceedings North American Crane Workshop 7:10–13.

Nesbitt, S. A., and A .S. Wenner. 1987. Pair formation and mate fidelity in sandhill cranes, pp. 117–122 *in* J. C. Lewis, editor. Proceedings 1985 Crane Workshop. U.S. Fish and Wildlife Service, Grand Island, NE.

Olson, S. M. Compiler. 2015. Pacific Flyway Data Book, 2015. U.S. Department of Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Vancouver, Washington.

Perkins, D. L., and D. E. Brown. 1981. The sandhill crane in Arizona. Arizona Game and Fish Department Special Publication 11, Phoenix, AZ. 47 pp.

Peterson, M. K., and R. C. Drewien. 1997. Hart's Basin, Colorado, a spring migration stopover area for Rocky Mountain sandhill and whooping cranes. Proceedings North American Crane Workshop 7:153–156.

Samuel, M. D., D. J. Shadduck, D. R. Goldberg, and W. P Johnson. 2005. Avian cholera in waterfowl: the role of lesser snow and Ross's geese as disease carriers in the Playa Lakes Region. Journal of Wildlife Diseases 41:48–57.

Schmitt, C. G., and B. Hale. 1997. Sandhill crane hunts in the Rio Grande Valley and southwest New Mexico. Proceedings North American Crane Workshop 7:219–231.

Snyder, S. B., M. J. Richard, R. C. Drewien, and J. C. Lewis. 1987. Pasteurella multocida infestation in a whooping crane associated with an avian cholera outbreak. Pages 149–155

in J. C. Lewis, editor. Proceedings 1985 Crane Workshop. Platte River Whooping Crane Habitat Maintenance Trust, Grand Island, NE.

Stahlecker, D. W. 1992. Crane migration in northern New Mexico. Pages 1–7 *in* D. A. Wood, editor. Proceedings 1988 North American Crane Workshop. Florida Game and Fresh Water Fish Commission, Nongame Wildlife Program Technical Report 12. Tallahassee, FL.

Tacha, T. C. 1988. Social organization of sandhill cranes from mid-continental North America. Wildlife Monographs 99.

Tacha, T. C., S. A. Nesbitt, and P. A. Vohs. 1992. Sandhill crane. *In* A. Poole, P. Stettenheim, and F. Gill, editors. The birds of North America, 31. Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists' Union, Washington, D.C.

Tacha, T. C., S. A. Nesbitt, and P. A. Vohs. 1994. Sandhill crane. pp. 76–94 *in* T. C. Tacha and C. E. Braun, editors. Migratory Shore and Upland Game Bird Management in North America. International Association of Fish and Wildlife Agencies, Washington, D.C.

Tacha, T. C., P. A. Vohs, and G. C. Iverson. 1984. Migration routes of sandhill cranes from Mid-continental North America. Journal of Wildlife Management 48(3):1028–1033.

Taylor, W.E. 1976. Sandhill crane habitat management on the Hiawath National Forest. Pages 44-50 *In* J.C. Lewis, ed. Proceedings of the international crane workshop. Oklahoma State University Publication Print., Stillwater.

Taylor, J. P. 1999. A plan for the management of waterfowl, sandhill cranes, and other migratory birds in the Middle Rio Grande Valley of New Mexico. U.S. Fish and Wildlife Service, Albuquerque, NM. 51 pp.

Taylor, J. P., and R. E. Kirby. 1990. Experimental dispersal of wintering snow and Ross' geese. Wildlife Society Bulletin 18:312–319.

Thorpe P. P., P. Donnelly, D. Collins. 2013 September 2013 Survey of the Rocky Mountain Population of Greater Sandhill Cranes. U.S. Fish and Wildlife Service Report unpublished.

U.S. Fish and Wildlife Service. 2011. Birding in the United States: a demographic and economic analysis. Addendum to the 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Report 2011-1. Arlington, VA.

Walkinshaw, L. H. 1949. The sandhill cranes. Cranbrook Institute of Science, Bloomfield Hills, MI, Bulletin 29. 202 pp.

Walkinshaw, L. H. 1973. Cranes of the world. Winchester Press, New York.

Windingstad, R. M. 1988. Nonhunting mortality in sandhill cranes. Journal of Wildlife Management 52:260–263.

Appendix A. Rocky Mountain population pre-migration staging areas and associated September estimates (Olson S. compiler, 2015 Pacific Flyway Databook).

Survey Area	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Colorado													
(1) Yampa Valley	693	223	318	NS	225	346	540	523	901	202	879	519	454
(2) Lower Elk River											532	17	236
(3) White River							63				91	140	115
(4) Williams Fork River											8	0	0
(5) Little Snake River											13	6	14
(6) Delta County		52	9		16	25	4	0	0	20	0	0	4
(7) San Luis Valley	34	1,135	515	230	1,352	654	378	287	68	94	71	136	266
Subtotal	745	1,410	1,052	230	1,743	1,080	1,162	985	1,347	413	1,594	1,258	1,089
Idaho													
(1) American Falls Reservoir	168	96	67	NS	89	124	91	68	52	103	288	155	71
(2) Ashton-St. Anthony	1,180	1,337	716	NS	807	798	830	444	400	450	662	654	840
(3) Bear River Valley	1,188	946	1,436	NS	1,690	921	780	1,211	908	559	410	778	1,272
(4) Blackfoot Reservoir	773	228	467	NS	284	752	361	429	298	434	333	520	537
(5) Camas NWR	347	381	532	NS	632	475	806	664	430	60	200	375	426
(6) Camas Prairie	0	0	0	NS	2	NS	103	5	32	NS	21	NS	0
(7) Carey Lake	0	0	0	NS	0	0	0	0	0	0	0	NS	0
(8) Chesterfield Reservoir	38	7	138	NS	27	111	109	103	135	40	103	49	196
(9) Grays Lake NWR	1,430	1,728	1,384	NS	1,943	41	1,483	1,115	972	262	907	839	489
(10) Henry's Lake Flats	21	58	35	NS	8	3	28	112	144	72	59	2	1
(11) Island Park Reservoir	2	0	2	NS	0	8	34	5	5	65	0	4	0
(12) Kilgore	NS	NS	0	NS	0	NS	0	NS	NS	NS	NS	NS	NS
(13) Market Lake WMA	0	1	0	NS	0	0	0	3	2	6	5	6	25
(14) Marsh Valley	202	120	245	NS	127	304	167	117	135	193	122	238	149
(15) Mud Lake WMA	371	164	100	NS	364	94	NS	137	13	103	248	53	54
(16) Oxford Slough-Swan Lake	93	220	145	NS	373	152	231	366	241	136	136	205	214
(17) Silver Lake	466	240	567	NS	316	397	381	309	399	281	421	431	575
(18) Teton Basin	1,543	1,626	1,834	NS	1,477	1,591	1,253	688	592	572	1,065	1,430	1,285
(19) Malad River	NS	NS	NS	NS	123	352	277	NS	271	96	248	325	320
Subtotal	7,822	7,152	7,668	0	8,262	6,123	6,934	5,776	5,029	3,432	5,228	6,064	6,454

Survey Area	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Montana													
(1) Blackfoot/Ovando Valley	514	57	361	48	94	147	166	199	328	240	159	311	0
(2) Cascade-Ulm	87	135	124	114	254	221	128	256	52	279	228	157	202
(3) Centennial Valley	46	0	2	?	0	2	25	0	15	8	96	85	1
(4) Clark Fork of the Yellowstone											452	427	678
(5) Deadman's Basin	481	160	336	208	253		523	580	407	293	225	306	349
(6) Dillon-Twin Bridges	1,681	1,788	1,443	NS	2,061	1,920	2,080	2,856	2,356	1,587	2,434	1,804	3,357
(7) Gallatin Valley	411	412	NS	305	338	430	260	314	356	184	215	182	309
(8) Helena Valley	170	104	56	41	54	37	176	65	200	214	327	216	190
(9) Melville	581	42	881	660	1,046	720	586	179	696	929	682	1,039	912
(10) Musselshell River	202	246	226	296	484	963	479	463	498	334	606	606	483
(11) Otter Creek	8	4	0	13	5	153	81	670	133	117	88	4	284
(12) Teton River-Eureka Reservoir		336	358	351	514	400	380	536	491	315	335	399	485
(13) Toston-Townsend	306	544	577	573	644	631	623	532	419	540	519	482	861
(14) Upper Madison Valley	120	121	298	NS	251	251	217	171	148	312	300	90	266
(15) Warm Springs	71	40	180	24	0	0	0	38	34	36	191	15	201
(16) White Sulphur Springs	175	487	442	406	392	403	461	394	329	369	297	349	578
(17) Whitehall	111	161	304	NS	119	141	144	82	180	119	64	83	337
Subtotal	4,964	4,637	5,588	3,039	6,509	6,419	6,329	7,335	6,642	6,150	7,218	6,555	9,493
Utah													
(1) Cache County	701	252	862		422	576	315	575	133	256	483	448	350
(2) Box Elder County	425	381	327		518	412	394	411	331	240	476	341	335
(3) Davis County	87	42	87		73	74	129	81	2	5	5	6	13
(4) Weber County	148	79	43		52	161	115	78	13	15	37	22	28
(5) Morgan County	18	30	32		46	55	33	42	52	82	89	87	91
(6) Bear River Valley	298	54	252		437	217	287	494	117	9	327	581	980
(7) Round Valley	52	59	43		27	61	71	53	19	95	59	72	100
(8) Summit County	39	55	32		30	31	39	22	2	18	6	19	27
(9) Jensen	747	1,195	922		540	1,917	809	1,412	786	995	1,066	992	1,520
(10) Pelican Lake area	21	74	4		66	204	66	28	0	299	127	176	220
(11) Leland Bench	10	18	42		190	0	25	46	8	55	30	11	10
(12) Wasatch County									23	29	27	28	24
Subtotal	2,546	2,239	2,646	0	2,401	3,708	2,283	3,242	1,498	2,109	2,732	2,783	3,698

Survey Area	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Wyoming													
(1) Baggs	4	0	5		2	0	2	0	0	0	5	0	0
(2) Bear River Valley	233	149	96	NS	510	264	153	488	539	490	379	163	692
(3) Greybull River/Otto	439	179	437		374	481	283	454	185	166	197	99	109
(4) Shoshone river/Ralston	742	680	938		386	196	389	470	341	446	366	384	109
(5) Worland					24	201	215	322	96	31	113	174	134
(6) Big Piney-Daniel	174	58	3	NS	46	138	91	76	14	117	239	19	114
(7) Bridger Valley	125	43	273		116	42	51	75	105	103	22	23	28
(8) Lonetree					50	NS	NS	0	0	0	0	4	0
(9) Farson	813	1,256	1,382	NS	1,431	1,957	1,463	1,297	988	1,665	1,354	1,295	2,087
(10) Hams Fork	4	24	161	NS	149	51	90	18	101	15	35	0	2
(11) Pinedale-Cora-Boulder	2	2	35	NS	8	0	45	2	0	3	0	0	0
(12)Seedskadee NWR	2	3	0		0	0	4	4	6	0	NS	NS	NS
(13) Saratoga	193	85	2		0	11	5	26	60	69	12	0	3
(14) Jackson Hole (Elk Refuge)	117	84	40		64	118	220	132	69	23	279	150	33
(15) Star Valley	316	234	191	NS	314	234	257	127	198	182	223	467	192
(16) Hidden Valley	39	119	43		0	3	19	40	88	112	56	122	0
(17) Ocean Lake	229	113	96		391	25	200	14	73	67	228	48	0
(18) Riverview Valley	14	43	209		42	105	126	181	115	98	80	60	93
(19) Barnum													
(20) Mayoworth													
(21) Sussex													
(22) Buffalo													
(23) 33 Mile													
(24) Dayton													
Subtotal	3,446	3,072	3,911	0	3,907	3,826	3,613	3,726	2,978	3,587	3,588	3,008	3,596
Total Cranes	19,523	18,510	20,865	3,269	22,822	21,156	20,321	21,064	17,494	15,417	20,360	19,668	24,330

Appendix B. Peak winter sandhill crane counts (all subspecies) in the Rio Grande Valley, New Mexico. Counts include three subspecies from the Rocky Mountain and Mid-continent populations.

Year	Bosque del Apache NWR Peak Count	Off-Refuge Count	MRGV[1] Peak Ground Count	MRGV Nov.-Feb. Average
1967	5,100	197	5,297	-
1968	5,500	661	6,161	-
1969	6,100	1,238	7,338	-
1970	9,800	2,171	11,971	-
1971	10,000	3,920	13,820	-
1972	10,500	2,476	12,976	-
1973	12,300	3,548	15,848	-
1974	8,500	4,951	13,451	-
1975	7,500	10,472	17,972	-
1976	9,900	5,549	15,449	-
1977	14,400	4,998	19,398	-
1978	11,800	2,747	14,547	-
1979	12,500	4,883	17,383	-
1980	13,928	5,409	19,337	-
1981	12,900	7,702	19,864	-
1982	12,000	10,864	22,864	-
1983	14,400	10,930	25,330	-
1984	10,900	5,529	16,429	15,056[4]
1985	11,000	6,029	17,029	12,751[4]
1986[2]	4,629	18,430	23,059	19,168[4]
1987[2]	8,334	20,282	29,126	19,421
1988[2]	11,302	12,056	23,358	20,809
1989[2]	6,196	10,357	16,553	15,383
1990[2]	13,810	10,660	24,470	19,037
1991[2, 3]	12,900	10,280	23,180	17,064
1992[2, 3]	11,160	10,300	21,460	18,412
1993[2, 3]	10,570	15,200	25,770	23,030
1994[2, 3]	15,700	9,200	24,900	21,162
1995[2, 3]	15,312	10,200	25,512	19,753
1996[2, 3]	13,000	8,250	21,250	18,093
1997[2, 3]	10,440	10,740	21,180	17,133
1998[2, 3]	12,950	15,400	28,350	24,203
1999[2, 3]	11,900	15,240	27,140	21,103
2000[2, 3]	12,200	18,690	30,890	21,023
2001[2, 3]	11,090	21,065	32,155	23,510
2002[2, 3]	13,500	16,565	30,065	23,399
2003[2, 3]	12,490	19,560	32,050	22,685
2004[2, 3]	13,941	14,813	28,754	22,876
2005[2, 3]	13,597	15,250	26,635	20,926
2006	9,802	--------	30,749	21,227

Year	Bosque del Apache NWR Peak Count	Off-Refuge Count	MRGV[1] Peak Ground Count	MRGV Nov.-Feb. Average
2007	14,506	-------	67,506	36,182
2008	15,684	-------	33,366	24,709
2009	7,550	-------	24,038	20,229
2010	10,860	-------	28,565	22,301
2011	13,449	-------	36,410	22,350
2012	14,671	-------	36,676	22,256

[1] Middle Rio Grande Valley (MRGV).
[2] Beginning in 1986, Bosque del Apache NWR was included in the Rio Grande transect. Previously, data consisted of ground counts by personnel of Bosque del Apache NWR.
[3] 1991–96 counts were based on weekly ground surveys during November–February.
[4] Denotes a year when data from ground count were used to determine the NDJ average.