

# Recent nesting and current status of Aplomado Falcon (*Falco femoralis*) in New Mexico

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## ABSTRACT

Aplomado Falcons (*Falco femoralis*) historically ranged within the United States from southeastern Arizona across southern New Mexico to western Texas, as well as in southernmost Texas. The species was resident and at least locally common within its United States range through the 1800s. It became uncommon by the 1930s and had largely disappeared by the 1940s, with the last documented nesting in 1952; it was federally listed as endangered in 1986. More recently, documentation of breeding Aplomado Falcons in northern Chihuahua, Mexico and increased reports from throughout the historic range in southern New Mexico suggested that natural recolonization of New Mexico's Chihuahuan Desert grasslands was underway. To assess the current status of the species in New Mexico, we conducted formal surveys and informal searches in suitable habitat in the southwestern and south-central portions of the state between 2000 and 2004. We found one territory that remained occupied by Aplomado Falcons from October 2000 through the project completion in 2004. This pair successfully fledged three young in 2002, the first such nesting by naturally occurring Aplomado Falcons in the United States in 50 years. We also observed at least eight other falcons, including a new pair in

the monitored territory and another pair nearby. Additionally during 2000–2004, we received credible reports of 11 falcons, including one pair, elsewhere in New Mexico, plus others just south of the United States–Mexico border. The existence of an occupied territory in southern New Mexico, plus reports of additional pairs and individuals on both sides of the international border, indicate the presence of a population in southern New Mexico and adjacent northern Chihuahua.

## INTRODUCTION

For over 50 years, the Aplomado Falcon (*Falco femoralis*) has been among the most elusive and sought-after bird species in the United States, where many authorities (e.g., Monson and Phillips 1981) concluded it no longer existed. Although known from the United States–Mexico border region, the majority of the falcon's distribution is from southern Mexico south through Central and South America (Keddy-Hector 2000). Within the United States, the species historically occurred in high-desert grasslands from southeastern Arizona and across southern New Mexico to western Texas, and in coastal prairies in southern Texas; it was considered regular in occurrence and fairly common, at least locally, through the 1800s by most authorities (e.g., Bendire 1892, Fisher 1893, Phillips et al. 1964, Hubbard 1970, Oberholser 1974). By the late 1930s, however, it had become decidedly uncommon, and by the 1940s it had largely disappeared from its U.S. range. A primary factor attributed to the decline was habitat alteration or loss, especially from brush encroachment into desert

grasslands (U.S.F.W.S. 1986, 1990, Hector 1987). Subsequently, organochlorine pesticides such as DDT were cited as inducing reproductive failure in southern Mexico, limiting the potential for the species to recolonize its former U.S. range (Kiff et al. 1980, Hector 1987, U.S.F.W.S. 1990). The United States Fish & Wildlife Service listed the northern subspecies, *septentrionalis*, as endangered in 1986 (U.S.F.W.S. 1986).

In New Mexico, the historic range included the southern tier of counties from Hidalgo and Grant eastward through Luna, Doña Ana, Otero, Eddy, and Lea and northward in the Rio Grande Basin through Sierra to Socorro (Figure 1). Bailey (1928) and Ligon (1961) implied a range contraction occurred by the early 1900s, limiting the falcon to the southwestern part of the state. By the 1930s, Aplomado Falcons had become rare in New Mexico, with the last specimen taken in 1939 in Hidalgo County and the last documented U.S. nest located in Luna County in 1952 (Ligon 1961, Hector 1987).

During the 1990s, however, an increase in Aplomado Falcon reports and verified records heightened interest in the possibility that the species might be recolonizing the southwestern United States (Williams 1997). Those sightings involved mostly single birds seen briefly at various locations. However, the presence of territorial falcons in southern New Mexico seemed likely, based on the number, frequency, and timing of observations, plus the proximity of a recently documented falcon population in nearby Chihuahua, Mexico (Montoya et al. 1997, Young et al. 2002, 2004). Since its discovery, the falcon population in Chi-

**Table 1. Estimated chronology of Aplomado Falcon nesting events during the 2001 and 2002 breeding seasons for four nests in Luna County, New Mexico. Egg and nestling stages estimated as 31–32 days and 38 days, respectively.**

Event	2001 Nest 1	2001 Nest 2	2002 Nest 1	2002 Nest 2
Nest site selected	Jan	May	Mar	May
Nest confirmed	8-Mar	25-May	22-Mar	16-May
Incubation initiated	8-15 Mar	9-25 May	23-29 Mar	19-23 May
No. of eggs	≥1	3	≥1	3
Hatching date	8-16 Apr	—	23-30 Apr	21-25 Jun
No. eggs hatched	≥1	0	Unknown	3
Nest fate	Failed	Failed	Failed	Successful
Nest failure date	28 Apr-6 May	1-7 June	29 Apr-5 May	—
No. of young fledged	—	—	—	3
Fledging date	—	—	—	29 Jul-2 Aug



huahua had been considered an obvious source of birds to repopulate areas within the historic range in the southwestern United States (Williams 1997, Keddy-Hector 2000).

The Aplomado Falcon recovery plan (U.S.F.W.S. 1990) recognized that an important first step in recovery was to document the status of any existing populations. According to Keddy-Hector (2000), a primary deficiency of ongoing conservation efforts was the continued lack of available information on the current status of natural populations. In response to this need and in light of increasing Aplomado Falcon reports, the U.S.F.W.S.'s New Mexico Ecological Services State Office and the New Mexico Department of Game and Fish sponsored this study to assess the status of native Aplomado Falcons in New Mexico. To accomplish this, we conducted formal surveys and informal searches for the species within its historic range in the state. In addition, we compiled and evaluated all recent Aplomado Falcon reports from the state to identify potential trends.

## METHODS

### Searches and monitoring

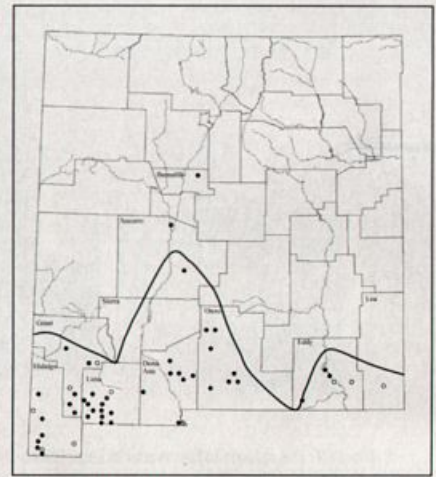
In early 2000, grassland areas with potential Aplomado Falcon habitat were identified in the counties of Grant, Hidalgo, Luna, and Doña Ana in southwestern and south-central New Mexico. These areas, within the species' former range, were chosen based on apparent habitat suitability and similarity to occupied habitat in nearby Chihuahua. Suitable falcon habitat in desert grasslands was considered to be generally flat, open grassland with less than 10 per cent shrub canopy cover (Young et al. 2002). Woody plants associated with such habitat include yucca (*Yucca* spp.), Longleaf Ephedra (*Ephedra trifurca*), Honey Mesquite (*Prosopis glandulosa*), Creosotebush (*Larrea tridentata*), and Tarbush (*Flourensia cernua*) (Montoya et al. 1997, Young et al. 2002). Potential habitat within our study area ranged from extensive, contiguous grasslands in some areas to various smaller-sized patches, these latter often occurring as linear swales within drainages, interspersed with shrublands.

We conducted formal surveys in all seasons between March 2000 and November 2004, spending some 850 hours surveying road-based survey routes in pre-identified grassland areas. Our formal survey protocol was based on survey methodology developed by U.S.F.W.S. (1999). Survey points were located at 1-km intervals along available roads. At each stop, the observer exited the vehicle and scanned the surrounding countryside for at least 5 minutes with binoculars and spotting scope. Surveys were conducted primarily in the morning or from late afternoon to dusk. On days with calm winds and cooler temperatures, surveys were continued through midday. Because breeding Aplomado Falcons rely on nests of other avian species, which provide an important component of their habitat (Keddy-Hector 2000), all raptors and ravens detected during surveys were recorded. We conducted repeated surveys of potential habitat to offset in part the difficulty in detecting transients or newly arrived falcons (Hector 1980). Because surveys were restricted to a subset of potential habitat accessible by road, the number of Aplomado Falcons observed was considered a minimum count and not an estimate of the total number of birds or occupied territories in New Mexico. In addition to formal surveys, we also conducted informal searches for Aplomado Falcons whenever we were in potential habitat in southern New Mexico.

Following initial detections of Aplomado Falcons, follow-up visits were made to determine the status of the bird(s) and the possible existence of territories. When the existence of a territory was confirmed, the site was monitored at least once each month through the end of the project. During the 2001 to 2004 breeding seasons (February–August), falcon pairs were monitored at intervals of 7–14 days, with monitoring consisting of 1–4-hour observation periods. To minimize disturbance, nests were observed from a minimum of 350 m with binoculars and spotting scope; active nests were not approached.

### Records of Aplomado Falcon after 1952

We compiled and evaluated all New Mexico



**Figure 1.** Map of New Mexico showing historic range of Aplomado Falcon (area below heavy line) and approximate locations of reports for the period 1960–2004 (n=53). Open circles are reports from 1960–1989 (n=10); closed circles are reports from 1990–2004 (n=43). Included are all photographically documented reports, most published reports, plus other reports considered certain or probable.

Aplomado Falcon records reported since the last known nesting in 1952. Data were obtained from published sources, archived documentation, and ongoing field work. The great majority of records were published in seasonal reports in *Audubon Field Notes* and its successors, as well as in *New Mexico Ornithological Society Field Notes*. In most cases, published reports were supported by original written documentation on file with the New Mexico Ornithological Society's Bird Records Committee and/or the New Mexico Department of Game and Fish; beginning in 1991, many reports were documented photographically. We inspected all available documentation for each record, and accepted for our analysis all photographically documented reports, most published reports, plus other reports judged certain or probable. We excluded reports lacking documentation or considered erroneous, as well as those determined to be duplicates of other reports. Since the early 1990s, precise locations for most reports, and especially for territorial falcons, have remained confidential, to protect the birds from undue disturbance.

All Aplomado Falcons found in New Mexico were judged as naturally occurring, native birds. In coastal southern Texas, where the species was extirpated and there were no nearby Mexican populations to assist natural recolonization, releases of captive falcons have initiated an introduced population (e.g., Perez et al. 1996); to date, however, no individuals from that population have been documented straying the necessary 1300 km to reach the high desert grasslands of southern New Mexico. Releases of captive falcons in West Texas began in 2002; to our knowledge, none of those marked individuals have been documented

**Table 2.** New Mexico Aplomado Falcon reports, 1960–2004 (n = 53). Data compiled from documentation, including photographic documentation where available, on file with the New Mexico Ornithological Society Bird Records Committee and/or the New Mexico Department of Game and Fish. Included are all photo-documented reports, most published reports plus, other reports considered certain or probable. Excluded are known duplicate reports and reports lacking documentation or considered erroneous.

Time period	Reports	Counties
1960–1969	2 reports of 3 birds	Eddy, Lea
1970–1979	4 reports of 4–6 birds	Doña Ana, Grant, Hidalgo
1980–1989	4 reports of 5 birds	Eddy, Grant, Hidalgo, Luna
1990–1999	24 reports of 26–31 birds	Doña Ana, Eddy, Grant, Hidalgo, Otero, Socorro
2000–2004	19 reports of 24 birds, including 4 pairs and 3 fledglings	Bernalillo, Eddy, Grant, Hidalgo, Luna, Otero





Figure 2. The Aplomado Falcon pair in Luna County, New Mexico 5 October 2000 was the first confirmed pair in the state since 1952. Photograph by Raymond A. Meyer.

in New Mexico or adjacent Chihuahua; no observations of Aplomado Falcons in New Mexico were of birds that were marked in Texas.

## RESULTS

### Aplomado Falcon Surveys

Surveys and searches detected one resident pair of Aplomado Falcons in Luna County in southwestern New Mexico 2000–2002 and another pair there in 2004. Also in Luna County, we observed at least eight additional Aplomado Falcons, including another pair, away from the monitored territory. Credible reports of additional falcons by other individuals during 2000–2004 were: three singles in Luna County; one in Hidalgo County; one in Bernalillo County; two each in Grant County and Eddy County; and a pair in Otero County.

Other raptors and corvids encountered during our surveys whose nests may be used by Aplomados included White-tailed Kite (*Elanus leucurus*), Swainson's Hawk (*Buteo swainsoni*), Red-tailed Hawk (*Buteo jamaicensis*), and Chihuahuan Raven (*Corvus cryptoleucus*). Chihuahuan Ravens were recorded on all formal surveys and were the most abundant nesting species. White-tailed Kites were conspicuous in several areas during the 2000 and 2001 survey seasons but were rare in subsequent years.

Formal surveys conducted in 2000 failed to detect Aplomado Falcons. However, upon revisiting a site in Luna County on 5 October 2000, a pair of Aplomado Falcons in recently molted adult plumage was found (Figure 2). The noticeable size difference between the birds, together with their behavior, indicated that they were a mated male-female pair. They continued to occupy the same general area through the winter, thereby confirming the existence of an established territory. Interestingly, this territory (referred to as "Luna" hereafter) closely coincided with the location of the last known historic U.S. nest from 1952 (Ligon 1961; H.

Campbell, *in litt.*). The Luna territory exhibited similarities with some occupied areas in northern Chihuahua (Meyer, pers. obs.), consisting of a mosaic of desert grassland and shrubland surrounding a large, open Tobosa (*Pleuraphis mutica*) swale. Conditions for falcon occupation seemed favorable at the time due to improved range management in recent years (M. Howard, Bureau of Land Management, pers. comm.) and high densities of avian prey in the allotment (Meyer, unpubl. data).

Formal surveys conducted in 2001 yielded no additional Aplomado Falcons other than the established pair. However, on 24 August 2001, we incidentally observed a single bird elsewhere in Luna County.

Much more intensive formal surveys in 2002, which doubled our previous efforts, produced at least four additional falcons, including a second pair. An adult female, first reported by others, was observed 2 February 2002 in the same general area as the single bird we sighted in August 2001. We continued to see that bird through February and early March along the United States–Mexico border. On the morning of 8 May 2002, a pair of falcons was detected during surveys north and west of the Luna territory. Those birds, perched in a large Soaptree Yucca (*Yucca elata*), exhibited pair bonding behavior before flying away. That same day, the original pair was observed nesting in its established territory, thereby confirming the existence of two pairs that day. The new pair was not relocated on subsequent searches or surveys; however, sightings of single falcons, which may have been members of that pair, were made in that general area during three later surveys in May. Finally, on 13 August 2002, an immature female falcon not affiliated with the resident pair was noted in the Luna territory but was not seen on subsequent surveys.

Aside from observations associated with monitoring the Luna territory (which included the resident female paired with a new male, plus a second male seen, in 2004), no additional Aplomado Falcons were detected during our less intensive surveys and searches in 2003 and 2004.

### Territory and Nest Monitoring

Monitoring of the Luna territory began upon its discovery in October 2000 and continued through 2004; the territory remained occupied throughout the monitoring period, although on some visits no falcons were observed. During the 2001 breeding season, the Luna pair made two unsuccessful nesting attempts (Table 1). The first nest was located one km north of the initial sighting. As early as 24 January, one of the falcons was

observed entering a stick nest in a Soaptree Yucca. Eggs were laid in early March, and incubation began about 12 March. From mid-March through April, the female and, to a lesser extent, the male were observed attending and incubating the nest. Based on an incubation period of 31–32 days (Keddy-Hector 2000), we estimated the eggs hatched about 8–16 April. The nest was active at least through 28 April but by 9 May was abandoned. An inspection of the nest revealed that at least one nestling had hatched but later died. Comparing juvenile feathers found near the nest with a photographic age key, we estimated the nestling was about 20 days old at the time of death. Several of the feathers showed damage only at the base of the shafts, suggesting that the nestling was plucked by an avian predator, such as a Great Horned Owl (*Bubo virginianus*) or Chihuahuan Raven. Great Horned Owls are known to depredate young Aplomado Falcons in South Texas (Perez et al. 1996) and are suspected of doing so in Chihuahua (C. Méndez González, pers. comm.) and were known to inhabit the vicinity of the Luna territory. Following the failure of the first nest, the pair initiated a second nest in a Soaptree Yucca 2.3 km to the west. At this nest, the female incubated three eggs from 25 May through 1 June, but by 9 June the falcons had abandoned the effort. The Luna pair remained on territory throughout the rest of that year but made no further nesting attempts.

In 2002, the Luna pair bred later than in 2001 and was observed inspecting a series of nests throughout the territory prior to nesting (Table 1). The first 2002 nest, situated in a Little-leaf Sumac (*Rhus microphylla*) and located between the two nest sites used the previous year, was discovered 22 March. In early May, at about the time eggs were expected to hatch, the nest was abandoned for unknown reasons. A second nest was initiated in mid-May in a Soaptree Yucca 3.3 km east of the first nest (Figure 3). We estimated the eggs hatched 21–25 June. This nest was successful, fledging three young at the end of July. For about a month, the juveniles continued to be attended by the adults (Figure 4). During this period, the juveniles gradually became more independent but continued to hunt with the adults. On 24 September and thereafter, no juvenile falcons were seen in their natal territory. The adult female remained on territory through 2002, but the male was not seen after 29 October.

No breeding activity was observed during the 2003 season. One adult, presumably the resident female, was periodically seen throughout the year in an expanded home range in the area occupied in previous years. We observed no other Aplomado Falcons in that area in 2003.



Through March 2004, only the female was seen on territory, but by late April, a male joined the female. We believe it unlikely that this male was a member of the original pair, although this could not be confirmed; we considered it a new pair. The pair engaged in breeding activity, including copulation and nest inspection, but we did not determine if egg laying occurred at any of three potential nest sites the falcons were seen inspecting. The pair was last seen together 18 May; by 23 May and thereafter, the female was alone. In mid-November and December, a male falcon was observed at the southern periphery of the Luna territory. Because of the substantial time interval (six months) since a male was last seen in the area, we assumed this later bird represented yet another male.

#### *Increased Presence of Aplomado Falcons in New Mexico*

Following the last known nest in 1952, no additional Aplomado Falcons were reported in that decade in New Mexico. During the subsequent three decades, reports of falcons were few and widely scattered and amounted to two reports in the 1960s and four reports each in the 1970s and 1980s (Figure 1, Table 2); none was confirmed with photographs or other tangible evidence, but together they implied a continuing, albeit low, level of occurrence during those decades. That changed, however, when single Aplomado Falcons were photographed near Tularosa, Otero County 25 June 1991 (Williams and Hubbard 1991) and near Bingham, Socorro County 14 August 1992 (Williams 1993). As the 1990s progressed, an increased presence of Aplomado Falcons became apparent; in all, the decade produced 24 credible reports involving 26–31 falcons in southern New Mexico, with three to six observations occurring per year by the latter part of the decade. By 2000–2004, not only did the high frequency of sightings continue (Figure 1, Table 2), but pairs of birds

were being encountered, one of which occupied a territory for at least two years and successfully fledged young.

Aplomado Falcons also occupy areas in northern Chihuahua, Mexico, where indications of the extent of their range were only recently revealed (e.g., Montoya et al. 1997). In 1998–1999, Young et al. (2002, 2004) conducted extensive falcon surveys in the northern portion of Chihuahua. They found 18 nests and a minimum of 79 falcons within a 100-km belt of the United States–Mexico border. Sightings of individual falcons were made in two successive years in the same locale within 12 km of the New Mexico border, and breeding falcons were observed within 50 km of the border. More recently, in April 2002, the wildlife group Profaua de Chihuahua conducted a brief survey in northern Chihuahua along the United States–Mexico border and reported four Aplomado Falcons, including one pair, not far from the Luna territory (A. Lafón Terrazas, pers. comm.). Immigration of Aplomado Falcons to New Mexico was documented when a first-year female Aplomado Falcon, banded as a nestling in Chihuahua in July 1999, was observed twice in September 1999 in Otero County, some 300 km from where it was raised (Meyer, pers. obs.).

#### **DISCUSSION**

The near half-century absence of breeding native Aplomado Falcons in the United States came to an end with the documentation of an occupied New Mexico territory in 2000 and the eventual successful fledging of three young in that territory in 2002. Our study, plus other recent observations, point to an increased presence of Aplomado Falcons in the Chihuahuan Desert of New Mexico. Although heightened awareness and vigilance likely contributed in part to the increase in reports, the accumulated observations nonetheless indicate a significant and growing presence of the species in the state. In the 1990s, Aplomado Falcon sightings in New Mexico involved single birds that were initially regarded as vagrants. The eventual discovery of pairs and successful breeding, however, provided encouraging signs that natural recolonization of the species' historic range in the Southwest may indeed be underway.

In adjacent Chihuahua, documentation of breeding Aplomado Falcons plus other recent sightings, together with recent findings in New Mexico, indicate the existence of a population along the border serving as a source for further colonization into historic range in New Mexico, Arizona, and western Texas. Based on this and other recent studies, falcons in northern Chihuahua and southern New Mexico



**Figure 3.** This Aplomado Falcon nest was in a Soaptree Yucca in Luna County, New Mexico; three young successfully fledged from this nest in July 2002. Photograph by Raymond A. Meyer.

should be considered a single interacting population (Williams 2000, Young et al. 2004). Apparent gaps in distribution within suitable habitats along the United States–Mexico border may be an artifact of relatively low survey effort and coverage in the United States and large portions in Chihuahua adjacent to the border, some of which have not been searched at all. Large amounts of time are required to detect Aplomado Falcons, including those on territory (Hector 1980), even with intensive survey methods (Young et al. 2004; this study). For example, in the formal survey portion of our study, Aplomado Falcons were detected only during the period when effort was at least double that of other survey periods.

There is great concern for the health of Chihuahuan Desert grasslands in this borderland region (Dinerstein et al. 2000, Curtin et al. 2002). Studies have documented several factors associated with human activities (e.g., excessive livestock grazing) as well as climate change as causing degradation or loss of desert grasslands, including shrub encroachment into these grasslands (Humphrey 1958, Hastings and Turner 1964, Buffington and Herbel 1965, York and Dick-Peddie 1969, Swetnam and Betancourt 1998). Large-scale habitat alterations were implicated as principal factors responsible for the Aplomado's original decline (U.S.F.W.S. 1986, 1990). Based on our understanding of Aplomado Falcon's habitat requirements in Chihuahuan Desert grasslands, we observe that much of this habitat in southern New Mexico is now fragmented by woody plant encroachment into formerly open grasslands. Such brush encroachment limits habitat suitability for the Aplomado Falcon as well as other sensitive grassland



**Figure 4.** These are three of a five-member Aplomado falcon family in Luna County, New Mexico, photographed 11 September 2002. This breeding event established the first successful U.S. nesting by naturally occurring Aplomado Falcons in 50 years. Photograph by Mike Howard, Bureau of Land Management.



species that require similar open grasslands, including Ferruginous Hawk (*Buteo regalis*), Sprague's Pipit (*Anthus spragueii*), and Baird's Sparrow (*Ammodramus bairdii*).

Montoya et al. (1997) and Young et al. (2002) found an association of Aplomado Falcons with grasslands having tall grass with dense basal cover and low woody plant densities. The U.S.F.W.S (1990) cited the need for range management practices that promote maintaining open pastures and other practices that improve potential Aplomado Falcon habitat. We believe it is imperative for government agencies, land managers, and conservation organizations to employ active international ecosystem management to encourage successful Aplomado Falcon recolonization and recovery, while minimizing risks to the falcons. The long-term success of any recovery effort ultimately will depend upon the ability of the habitat to support the species. The current grazing permittee at the Luna territory has implemented a conservative grazing regime aimed at improving range conditions (M. Howard, Bureau of Land Management, pers. comm.), which could serve as a model for successful management of Aplomado Falcon habitat consistent with existing land uses throughout much of the species' northern range.

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### Literature cited

Bailey, F. M. 1928. *Birds of New Mexico*. New

Mexico Department of Game and Fish, Santa Fe, New Mexico.

Bendire, C. E. 1892. Life Histories of North American Birds. *United States National Museum Special Bulletin* 1: 306–307.

Buffington, L. C., and C. H. Herbel. 1965. Vegetational changes on a semidesert range from 1858 to 1963. *Ecological Monographs* 35: 139–164.

Curtin, C. G., N. F. Sayre, and B. D. Lane. 2002. Transformations of the Chihuahuan Borderlands: grazing, fragmentation, and biodiversity conservation in desert grasslands. *Environmental Science and Policy* 5: 55–68.

Dinerstein, E., D. Olson, J. Atchley, C. Loucks, S. Contreras-Balderas, R. Abell, E. Inigo, E. Enkerlin, C. Williams, and G. Castilleja. 2000. Ecoregion-based conservation in the Chihuahuan Desert: a biological assessment. World Wildlife Fund, Comision Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), The Nature Conservancy, PRONATURA Noreste, and Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM). Washington, D.C.

Fisher, A. K. 1893. The Hawks and Owls of the United States in their Relation to Agriculture. *United States Department of Agriculture Bulletin* 3.

Hastings, J. R., and R. M. Turner. 1964. *The changing mile*. University of Arizona Press, Tucson, Arizona.

Hector, D. P. 1980. Our rare falcon of the desert grassland. *Birding* 12: 92–102.

—. 1987. The decline of the Aplomado Falcon in the United States. *American Birds* 41: 381–389.

Hubbard, J. P. 1970. *Check-list of the birds of New Mexico*. New Mexico Ornithological Society Publication No. 3.

Humphrey, R. R. 1958. The desert grassland; a history of vegetational change and an analysis of causes. *Botanical Review* 24: 193–252.

Keddy-Hector, D. P. 2000. Aplomado Falcon (*Falco femoralis*), in A. Poole and F. Gill, eds., *The Birds of North America*, No. 549. The Birds of North America, Inc., Philadelphia, Pennsylvania.

Kiff, L. F., D. B. Peakall, and D. P. Hector. 1980. Eggshell thinning and organochlorine residues in the Bat and Aplomado Falcons in Mexico. *Proceedings of the International Ornithological Congress* 17: 949–952.

Ligon, J. S. 1961. *New Mexico birds and where to find them*. University of New Mexico Press, Albuquerque, New Mexico.

Monson, G., and A. R. Phillips. 1981. *Annotated checklist of the birds of Arizona*. University of Arizona Press, Tucson, Arizona.

Montoya, A. B., P. J. Zwank, and M. Cardenas. 1997. Breeding biology of Aplomado Falcons in desert grasslands of Chi-

huahua, Mexico. *Journal of Field Ornithology* 68: 135–143.

Oberholser, H. C. 1974. *The Bird Life of Texas*. Volume 1. University of Texas Press, Austin, Texas.

Perez, C. J., P. J. Zwank, and D. W. Smith. 1996. Survival, movements and habitat use of Aplomado Falcons in southern Texas. *Journal of Raptor Research* 30: 175–182.

Phillips, A., J. Marshall, and G. Monson. 1964. *The Birds of Arizona*. University of Arizona Press, Tucson, Arizona.

Swetnam, T. W., and J. L. Betancourt. 1998. Mesoscale disturbance and ecological response to decadal climatic variability in the American Southwest. *Journal of Climate* 11: 3128–3147.

United States Fish and Wildlife Service [U.S.F.W.S.]. 1986. Final rule; determination of the Northern Aplomado Falcon to be an endangered species. *Federal Register* 51: 6686–6690.

—. 1990. Northern Aplomado Falcon recovery plan. United States Fish and Wildlife Serv., Albuquerque, NM.

—. 1999. Interim survey methodology for the Northern Aplomado Falcon in desert grasslands. United States Fish and Wildlife Service, New Mexico Ecological Services State Office, Albuquerque, NM.

Williams, S. O. III. 1993. The autumn migration: New Mexico Region. *American Birds* 47: 131–132.

—. 1997. Recent occurrences of Aplomado Falcons in New Mexico: Is natural recolonization of historic range underway? *New Mexico Ornithological Society Bulletin* 25: 39.

—. 2000. The fall migration: New Mexico Region. *North American Birds* 54: 87.

Williams, S. O. III, and J. P. Hubbard. 1991. The nesting season: New Mexico Region. *American Birds* 45: 1147, 1180.

York, J. C., and W. A. Dick-Peddie. 1969. Vegetation changes in southern New Mexico during the past hundred years. Pp. 157–166 in: W. G. McGinnis and B. J. Goldman, eds. *Arid lands in perspective*. University of Arizona Press, Tucson, Arizona.

Young, K. E., B. C. Thompson, D. M. Brown, Q. H. Hodgson, J. L. Lanser, A. Lafón Terrazas, W. R. Gould, and R. Valdez. 2002. Characterizing and predicting suitable Aplomado Falcon habitat for conservation planning in the northern Chihuahuan Desert. New Mexico Cooperative Fish and Wildlife Research Unit, Las Cruces, New Mexico.

Young, K. E., B. C. Thompson, A. Lafón Terrazas, A. B. Montoya, and R. Valdez. 2004. Aplomado Falcon distribution and abundance in the northern Chihuahuan Desert of Mexico. *Journal of Raptor Research* 38: 107–117. ☉