Aplomado Falcon Recovery Plan

1990

ALBUQUERQUE, NEW MEXICO

NORTHERN APLOMADO FALCON RECOVERY PLAN

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for

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Regional Director

DISCLAIMER

This is the completed Northern Aplomado Falcon Recovery Plan. It does not necessarily represent official positions or approvals of cooperating agencies, and does not necessarily represent the views of all individuals who helped prepare the plan. This plan is subject to modification as dictated by new findings, changes in species status, and completion tasks described in the plan. Goals and objectives will be attained and funds expended contingent upon appropriations, priorities, and other constraints.

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SUMMARY

The current Endangered status of the northern aplomado falcon (*Falco femoralis septentrionalis*) should be changed to Threatened when: A minimum self-sustaining population of 60 breeding pairs has been established in the United States (this goal may be modified after we learn more about suitable habitat within the United States). Patches of coastal prairie and desert grassland must be maintained in (or restored to) a condition providing optimal habitat for northern aplomado falcons through application of grazing, prescribed fire, and brush control. Use of pesticides such as DDT and dieldrin must be permanently eliminated within areas inhabited by northern aplomado falcons and their prey. Aplomado falcons should be reestablished in suitable parts of the southwestern U.S.

Critical information needed to implement and refine management procedures includes understanding: (1) the extent to which pesticide contamination is impacting populations in eastern Mexico, (2) densities and total numbers in Mexico, (3) the amount of suitable habitat remaining in Mexico and the U.S., (4) habitat requirements in temperate and subtropical grasslands, (5) the movements of non-breeders, and (6) improved techniques for captive-rearing northern aplomado falcons and restoring them to the wild.

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PART I

BIOLOGICAL INFORMATION

Aplomado falcons (Falco femoralis) (Figures 1-3) inhabit desert grasslands and savannas of Latin America and formerly inhabited desert grasslands and coastal prairies of Texas , New Mexico, and southeastern Arizona. Geographic distribution includes most of South America from Tierra del Fuego to Venezuela and Ecuador and from near sea level to above 3000 m in the Andes. The species also ranges through Mesoamerica. On March 27, 1986, the northern aplomado falcon (Falco femoralis septentrionalis) was designated an endangered species in response to: (1) extirpation in the U.S. (Hector 1987), and (2) evidence of population declines and severe pesticide contamination in eastern Mexico (Kiff et al. 1980). Unless otherwise noted, the term falcon in this report refers to northern aplomado falcon, which are larger and paler than the aplomado of Central America and eastern South America.

Historical Background

The aplomado falcon was first collected in North America in 1852 (Heerman 1854). At least 124 sets of eggs and 56 skins had been collected in the U.S. by 1920, and most of these specimens were taken in south Texas between 1890 and 1910 (Hector 1981). Although this falcon continued to nest in the U.S. as late as 1952 (Ligon 1961; Lehmann, pers. comm.), it disappeared from most of its U.S. range by 1940 (Hector 1987).

In Mesoamerica the status of the falcon is not well known. Few specimens have been collected in central or western Mexico or in northern Central America. It appears the subspecies occurs regularly only on the Gulf-coastal plain of Mexico in Veracruz, Campeche, Tabasco, and Chiapas. Unfortunately, falcons in Veracruz

Figure 1. Adult northern aplomado falcon

are severely contaminated with pesticides (Kiff et al. 1980). The impact of these pesticides on the falcon's productivity has not been determined.

Taxonomy

Along with Falco femoralis septentrionalis, two other subspecies have been described: Falco femoralis pichinchae (Chapman) of western South America, and Falco femoralis femoralis (Temminck) in the remaining portions of South and Central America. The subspecies are distinguished by differences in relative dimensions, the degree of completeness of their abdominal bands ("cummerbunds"),

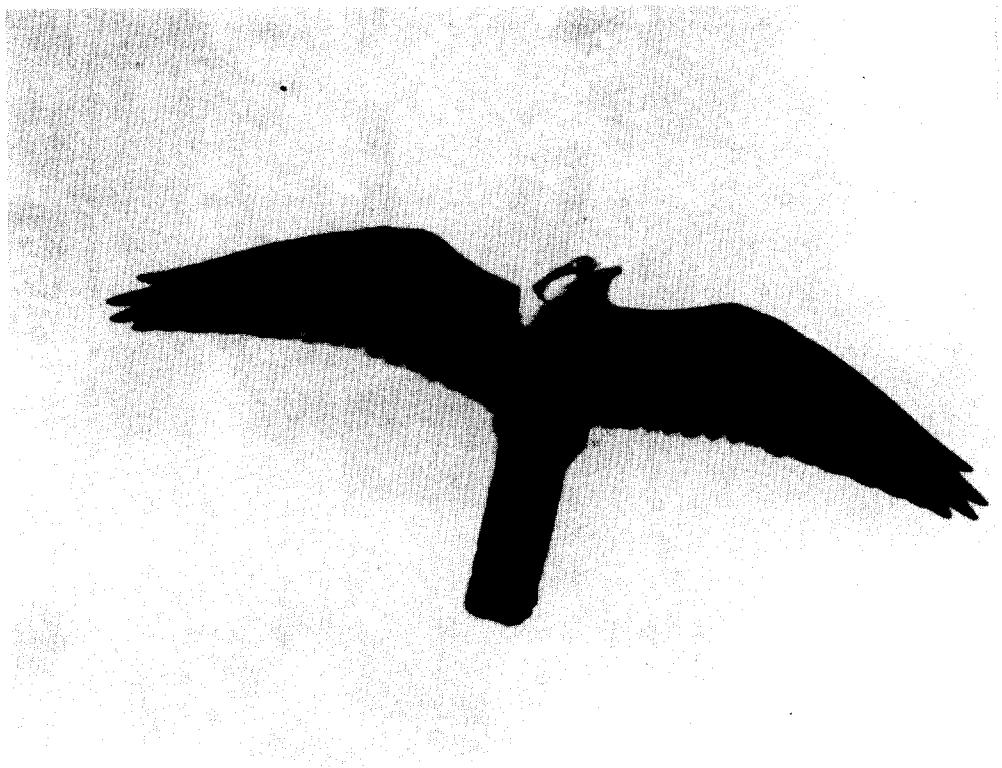

Figure 2. Adult northern aplomado falcon in flight.

and the darkness (or lightness) of their dorsal plumages (Table 1, Blake 1977).

The original description of the northern aplomado falcon (Todd 1916) was based on specimens collected in 1887 at Ft. Huachuca, Arizona (Bendire 1892). Falco femoralis femoralis is only slightly smaller and tends to be darker dorsally but may intergrade with F. f. septentrionalis. The abdominal band of F. f. femoralis is usually complete with only a slight mid-ventral narrowing. Falco femoralis pichinchae is larger, darker, has buffier underparts than F. f. femoralis, and has an abdominal band that is narrow or incomplete mid-ventrally (Blake 1977).

Figure 3. Immature northern aplomado falcon.

Geographic Distribution

This subspecies once extended from Trans-Pecos Texas, southern New Mexico, and southeastern Arizona (Figure 4) to Chiapas and the northern Yucatan along the gulf coast of Mexico, and along the Pacific slope of Central America north of Nicaragua (Howell 1972). Northern aplomado falcons have been collected in Arizona, New Mexico, Texas, Tamualipas, Veracruz, Chiapas, Campeche, Tabasco, Chihuahua, Coahuila, Sinaloa, Jalisco, Guerrero, Yucatan, San Luis Potosi, and along the Pacific coast of Guatemala and El Salvador. The falcons of Belize and

the Gulf-slope of Nicaragua are F. f. femoralis (Russell 1964, Howell 1972, Blake 1977). On the Pacific slope, Belize, and the Gulf-slope, the nominate subspecies F. f. septentrionalis may intergrade. Specimens collected in western Nicaragua are intermediate in size between these two forms (Howell 1972).

TABLE 1. Relative sizes (ranges and arithmetic means in mm) of the three subspecies of the aplomado falcon (all measurements from Blake 1977).

	Aplomado Falcon Subspecies[1]		
Measurement and sex	F. f. femoralis	F. f. septentrionalis	F. f. pichinchae
Wing chord			
Males	226-254 (237)	248-267 (257)	235-272 (258)
Females	245-282 (263)	272-302 (290)	290-311 (298)
Tail			
Males	142-170 (153)	172-193 (182)	151-179 (168)
Females	155-195 (172)	192-207 (199)	195-210 (202)

[1]Sample sizes are 23 males and 25 females of F. f. femoralis, 8 males and 7 females of F. f. septentrionalis, and 5 males and 10 females F. f. pichinchae.

Former and Current Status in the U.S.

Because of uneven collecting effect, it is difficult to determine the former abundance of the northern aplomado falcon in the U.S. Merrill (1878), Bendire (1892), Smith (1910), and Strecker (1930) all believed the species was fairly common ("frequently encountered", "quite common", "fairly common", or "not very uncommon") in the U.S. The numbers of collected specimens support this view (Hector 1982, Keddy Hector 1988).

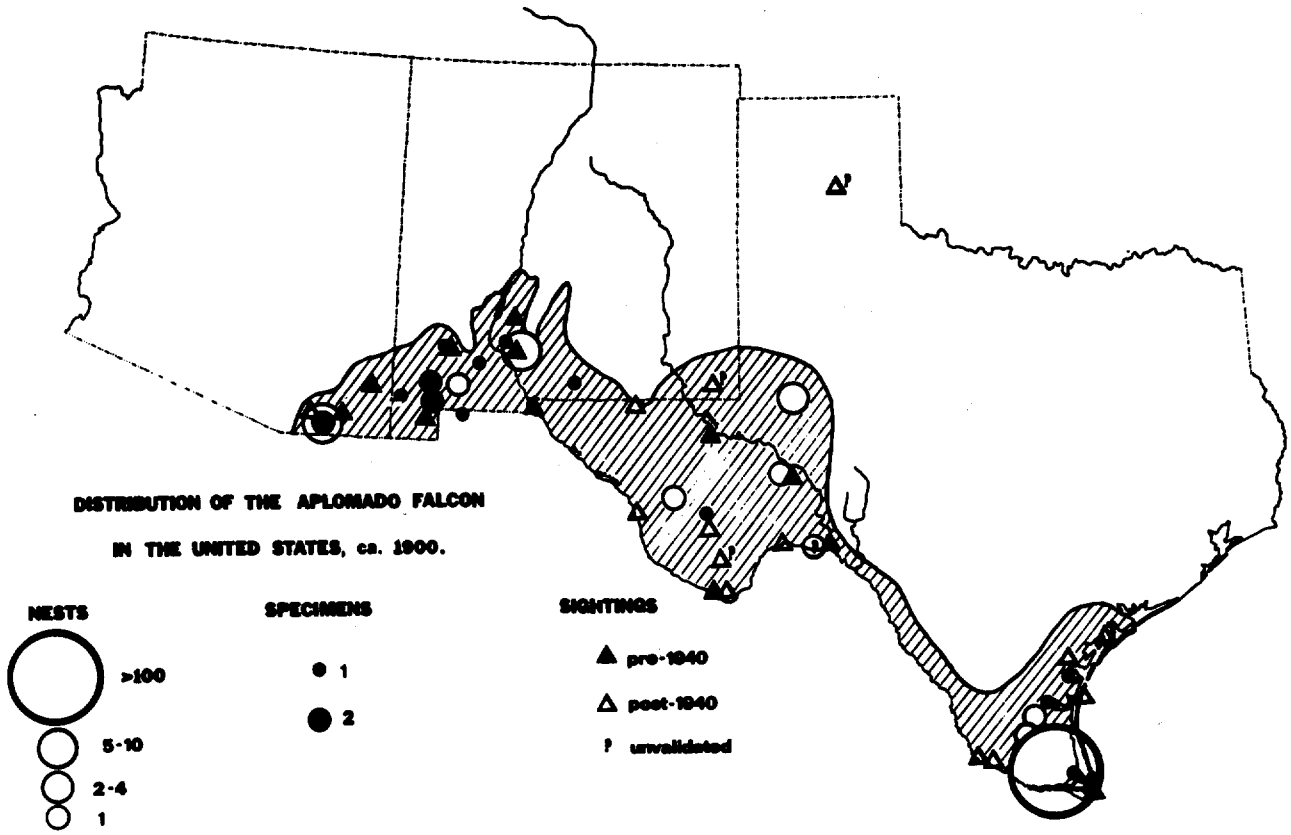

Figure 4. Distribution of northern aplomado falcon in the United States about 1900.

Collectors found northern aplomado falcons nesting in the U.S. each year from 1892 to 1914 (Keddy Hector 1988). At least 131 egg sets and 66 skins have been collected north of Mexico. After 1914, pairs of falcons or nests were discovered nearly every year until 1930 (Hector 1987).

Aplomado falcon egg sets collected 1890-1915 on the Texas coastal bend outnumber egg sets of the white-tailed hawk (Buteo albicaudatus) and crested caracara (Polyborus cheriway) collected in the same area and period

(Hector 1987). White-tailed hawks and caracaras are still regularly encountered in this region.

In 1949, Val Lehmann collected on the King Ranch of Texas the last U.S. aplomado falcon specimen (stored at the Oklahoma State University Museum). He continued to see aplomado falcons in this area until the 1950's (pers. comm.). Aplomado falcons were less common inland. Near Midland, Texas, in 1904, Strecker (1930) found three nests of the aplomado falcon (in abandoned Swainson's hawk [Buteo swainsoni] or Chihuahuan raven [Corvus cryptoleucus] nests) during a period when he also located 38 active Swainson's hawk nests.

In 1908 and 1909, Ligon (in Bailey 1928) found "several" active nests on the Jornada del Muerto of south-central New Mexico. Benson (in Bendire 1892) found five active nests near Ft. Huachuca, Arizona, in 1887. Other localities where aplomado falcons may have nested include Ft. Bowie in Cochise County, Arizona; Hachita, Animas, and the Rio Mimbres in southern New Mexico; and the grasslands surrounding the Davis Mountains and other mountain ranges of Trans-Pecos Texas. The most recent nesting attempts in the U.S. were in Brooks County, Texas in 1941 (Oberholser 1974) and near Deming, New Mexico in 1952 (Ligon 1961).

Eighteen aplomado falcons were successfully hacked on the Laguna Atascosa National Wildlife Refuge on the southern Texas Gulf Coast between 1986 and 1989. Birds may now be seen on the refuge almost year-round. The Peregrine Fund plans to continue hacking activities on the refuge and to start at a second site near Matamoros, Mexico in 1990. Individual aplomado falcons have also been seen near the Gabrielson and Palmview Units of Rio Grande Valley National Wildlife Refuge and near Harlingen, Texas, in the

last few years. Laguna Atascosa National Wildlife Refuge and some private lands on its borders are the only areas in the United States categorized as habitat occupied by aplomado falcons in 1990 (Figure 5).

Cause of Decline

Brush encroachment and agricultural development have destroyed much of the grassland habitat required by this falcon (Hector 1987, Keddy Hector 1988). Catastrophic channelization of once permanent desert streams (Hastings and Turner 1964) has destroyed many wetland communities that may have been important breeding areas for avian prey of northern aplomado falcons.

Collecting may have been detrimental in some localities. However, populations of birds of prey are generally resilient to localized shooting pressure (Ratcliffe 1980, Newton 1979).

Pesticide contamination may have further reduced habitat quality for northern aplomado falcons inhabiting the U.S. This is likely because: (1) this falcon is an upper trophic level predator; (2) nesting pairs were present in the U.S. at the beginning (post-1947) of the DDT era (Hector 1983, 1987); and (3) falcons nesting at the same time in eastern Mexico were heavily contaminated by residues of DDT (Kiff et al. 1980).

Natural History

Feeding Preference

Northern aplomado falcons capture small birds, and various insects, rodents, and reptiles (Grayson in Lawrence 1874, Bendire 1892, Cherrie 1916, Friedmann and Smith 1950, 1955, Mitchell 1957, Ligon 1961, Hector

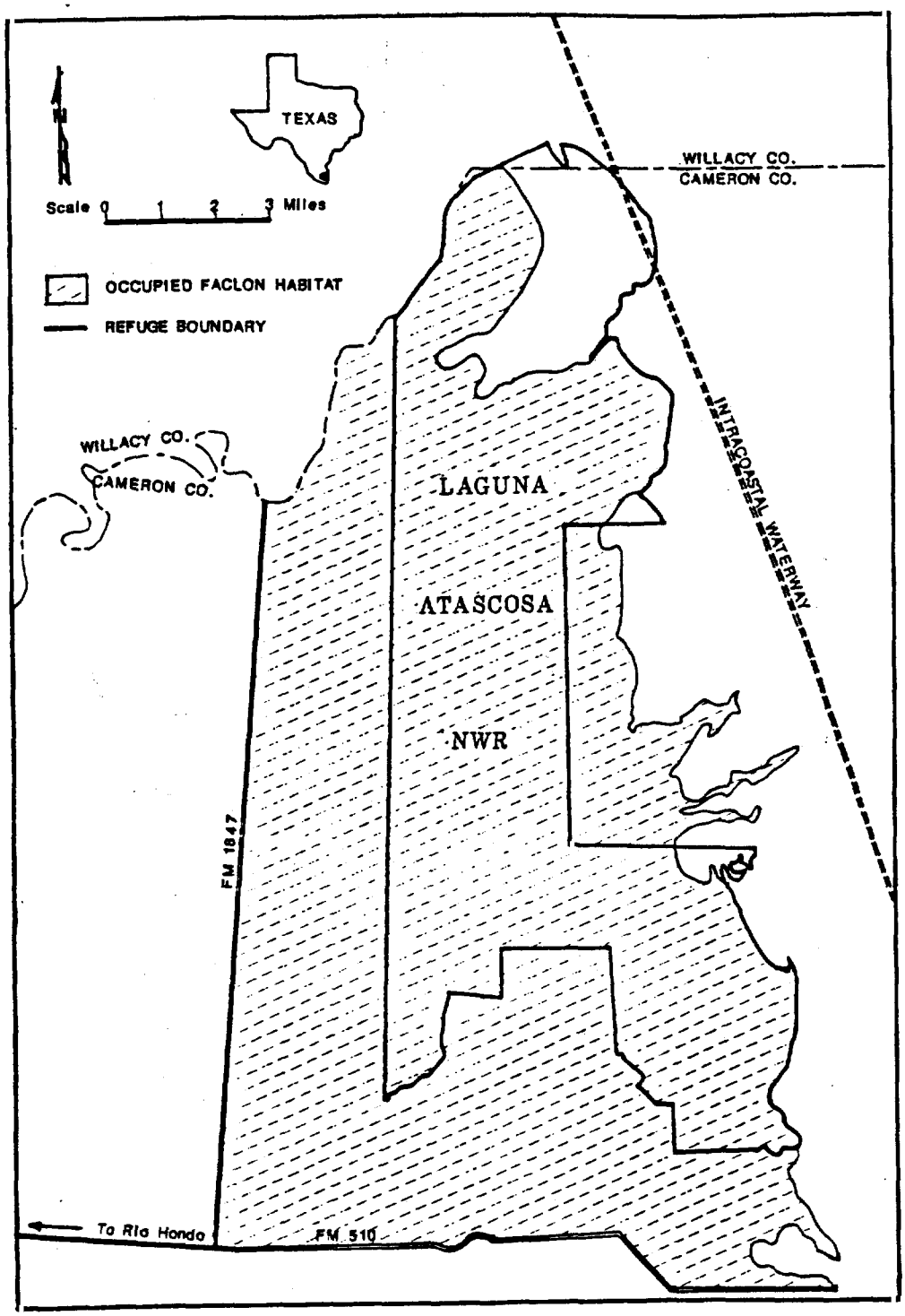

Figure 5. Laguna Atascosa National Wildlife Refuge and bordering private lands utilized by aplomado falcons in 1990.

1985). In eastern Mexico, birds accounted for 97% of total prey biomass but insects represented 65% of prey individuals (Hector 1985). The average weight of birds in the sample of observed prey was 67 g; 77% of captured birds weighed less than 100 g. However, these falcons also capture birds as large as Chachalacas (Ortalis vetula; about 570 g) and pigeons (Columba spp.; about 300 g) (Friedmann and Smith 1950, 1955; Hector 1985).

Favorite avian prey of northern aplomado falcons (e.g., doves, cuckoos, woodpeckers, blackbirds, flycatchers, thrushes, and various fringillids) feed in trees or on the ground and move between feeding (or watering) points with direct "point-to-point" flights of varying lengths. Less aerial species such as quail, seedeaters, meadowlarks, and small rodents are also captured, as are slow-flying insectivores, such as bats, nighthawks, and pauraques (Hector 1985). Fast aerial-feeding insectivores, such as swifts and swallows are not preferred prey. Predominant avian prey in eastern Mexico include mourning dove (Zenaida macroura), white-winged dove (Z. asiatica), common ground-dove (Columbina passerina), yellow-billed cuckoo (Coccyzus americanus), groove-billed ani (Crotophaga sulcirostris), common nighthawk (Chordeiles acutipennis), whip-poor-will (Caprimulgus vociferus), golden-fronted woodpecker (Melanerpes formicivorous), great-tailed grackle (Quiscalus mexicanus), eastern meadowlark (Sturnella magna), melodious blackbird (Dives dives), various orioles (Icterus spp.), indigo bunting (Passerina cyanea), Cassin's sparrow (Aimophila cassinii), lark sparrow (Chondestes grammacus), dickcissel (Spiza americana), and lark bunting (Calamospiza melanocorys). Other vertebrate prey include frogs, lizards, bats, kangaroo rats (Dipodomys spp.), pocket mice (Perognathus spp.), and white-footed mice (Peromyscus sp.). Documented invertebrate

prey includes grasshoppers, beetles, dragonflies, cicadas, crickets, butterflies, moths, wasps, and bees.

Hunting Behavior

These falcons typically chase small birds and insects during horizontal flights they initiate from tree perches (Hector 1986a, 1987). Insects are generally captured during the falcons' gliding or slow-flapping flights. They also search for prey while on perches in the inner branches of trees or on more exposed positions in the upper portions of a tree crown. Aplomado falcons readily continue chases on foot when prey animals enter crowns of trees, small shrubs, or dense grass.

Male and female often hunt together when chasing small birds. In these "tandem hunts" males tend to hover overhead while females chase "grounded" prey on foot. When nestlings are present, these hunts generally take place within view of the nest. At times falcons even interrupt incubation to participate in hunts started by a mate.

In eastern Mexico most hunting occurs before noon or during late afternoons within 1 km of the nest. Distant soaring hunts by males take place later in the day if short-range hunts are unsuccessful. In distant hunts, males soar up and travel 3-4 km from nesting territories before descending in slanting dives to capture prey or land on a hunting perch. Falcons sometimes acquire food through kleptoparasitism. They have been observed taking small mammals from black-shouldered kites (Elanus leucurus) and American kestrels (Falco sparverius; Hector, pers. observations). One falcon was observed taking crayfish from a heron (W. Clark, pers. comm.).

Nest Sites

Falcons do not construct stick platforms (Brown and Amadon 1964, Cade 1982); consequently, availability of nesting platforms may be a factor limiting populations within otherwise ideal habitat. In Veracruz and Chiapas, 4 of 15 nesting platforms of aplomado falcons were large arboreal bromeliads (Figure 5). The other nests were stick platforms built by brown jays (Psilorhinus morio), roadside hawks (Buteo magnirostris), gray hawks (B. nitidus), black-shouldered kites, or crested caracaras (Figure 6). Only one set of northern aplomado falcon eggs has been reported from a cliff site (zoological records of F.B. Armstrong). This nest site, however, consisted of a stick platform on a ledge, not simply a bare ledge. No ground nests have been reported.

In the U.S., these falcons used stick nests of the Swainson's hawk, crested caracara, and Chihuahuan raven (Merrill 1878, Bendire 1892, Strecker 1930). In sub-tropical or desert localities, where large arboreal bromeliads do not exist, the availability of nests for aplomado falcons is probably influenced mainly by the abundance of birds that build large nests (crows, ravens, hawks, kites).

Northern aplomado falcons accept a variety of platform types and sizes (Hector 1981, 1988). The outside diameter of a sample of five falcon nests in eastern Mexico ranged from 28 cm (originally constructed by black-shouldered kite or brown jay) to 100 cm (originally a caracara nest). Nest cup diameters ranged from 6 to 18 cm (Hector 1981).

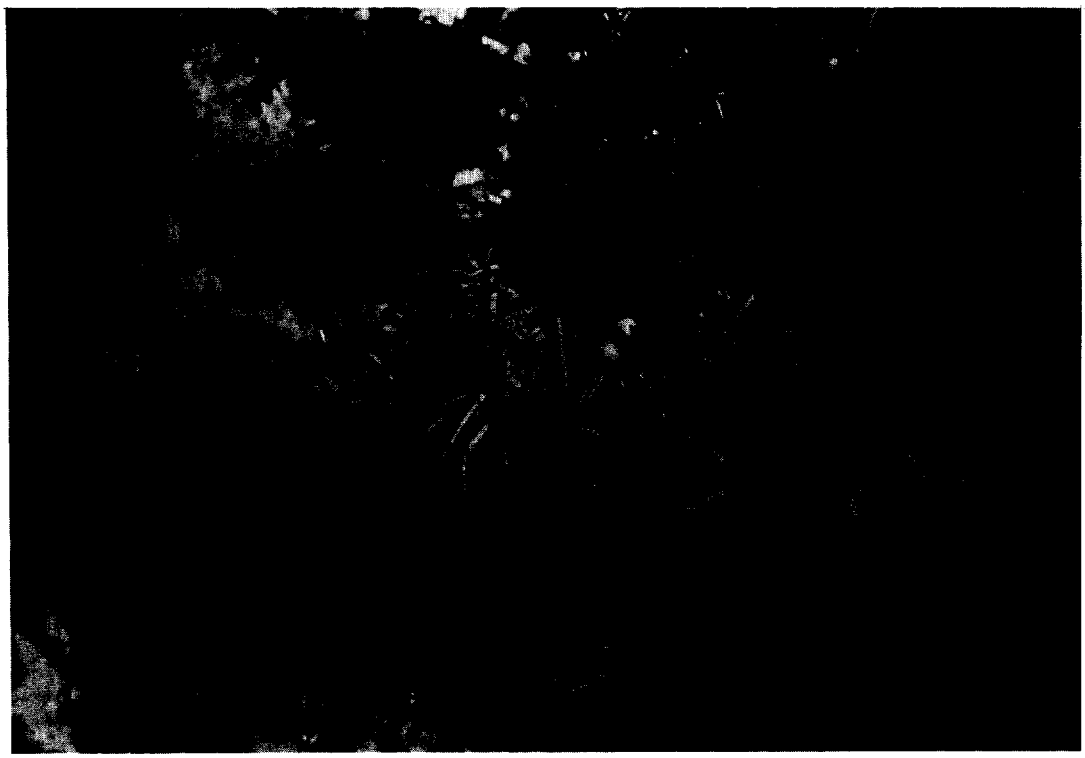

Figure 6. Aplomado falcon nest with eggs in bromeliad.

Habitat Requirements

Falcon habitat consists of open terrain with scattered trees or shrubs (Figures 7-9). In Mexico, they inhabit palm and oak savannas, open tropical deciduous woodlands, wooded fringes of extensive marshes, various desert grassland associations, and upland pine parklands (Grayson in Lawrence 1874, Webster and Orr 1952, Keddy Hector 1988).

In suitable habitat, (1) inter-tree distances averaged 30 m (range 15-45 m); (2) tree densities averaged 19 trees per 40 ha (about 100 acres);

Figure 7. Aplomado falcon eggs in abandoned stick nest.

(3) tree height averaged 9 m; and (4) ground cover vegetation was 92% within 75 cm of the ground and 70% within 50 cm of the ground. Trees generally were scattered so sparsely that the crowns did not form a continuous canopy. Tree crowns covered an average of only 7% of available space in nesting areas (Keddy Hector 1988).

In the United States of America, the species was found along yucca-covered sand ridges in coastal prairies, riparian woodlands in open grasslands, and in desert grasslands with scattered mesquite and yucca (Henshaw 1875, Merrill 1878, Bendire 1892, Ligon 1961).

Figure 8. Oak savanna habitat in central Veracruz, Mexico.

Home Range

Population densities in eastern Mexico may be as high as 30-40 pairs/100 km^2. Although raptor population densities show considerable variation from region to region depending on habitat quality (Newton 1979), these area estimates for aplomados seem low in comparison with the spatial requirements of other falcon species. A regression equation derived from data on other falcons is :

$$LOG\ Y = 1.687(LOGX) - 3.212,$$

Figure 9. Acacia savanna habitat in northern Veracruz, Mexico.

Where Y is home range site (km^2/pair), and X is the sum of male and female body masses in grams. The sum of average masses of these male and female falcons is about 650 g, which yields a predicted home range size of 34 km^2 (or about 8,400 acres) for this species.

Small bird abundance is likely an important determinant of potential nesting density for this species. In eastern Mexico, for example, estimated densities of birds averaged 9 birds/ha at active falcon nest sites (Hector 1987). Small bird densities were similar (10 birds/ha) at

Figure 10. Yucca/mesquite habitat in the United States.

four Texas coastal brush-grassland sites (Roth 1977). In creosote-grassland associations of western Texas and south-central New Mexico, densities of 12 birds/ha were noted (Dixon 1959, Raitt and Maze 1968).

Corvids and raptors average 1.7 birds/ha at eastern Mexican nesting areas (Keddy Hector 1987), but only 0.01 birds/ha at two Chihuahuan Desert sites (Dixon 1959, Raitt and Maze 1968). These densities are important because these bird groups build stick nests which falcons use for nest platforms. Although falcons would presumably be much rarer in desert areas than in lowland savanna, it is impossible at this time to make any

reasonable inferences about the relationships between prey abundance, nest site availability, and spatial requirements. Species such as the European hobby (Falco subbuteo) and red-necked falcon (Falco chicquera) have spatial requirements that vary intraspecifically 1 to 2 orders of magnitude. If this is also true for northern aplomado falcons, 60 km^2 per pair may represent a reasonable upper limit of their home range size.

Seasonal Movements

Little is known about the migratory behavior of these falcons. In eastern Mexico, pairs remain on their nesting territories year-round. The subspecies apparently overwintered in the U.S. because numerous specimens were taken there in winter (Hector 1981,1987). No specimens have ever been collected in western Mexico during the breeding season.

Nesting Chronology

Northern aplomado falcons nest in eastern Mexico during the dry season (January-June). Adults may produce clutches throughout this period (pers. observations), but most clutches are laid March-May. Falcons have been found incubating in mid-June, thus some young must still be dependent on their parents in August. In the U.S., most aplomado falcon egg sets were collected in April-May (Hector, unpubl. data).

Incubation lasts 31-32 days, nestlings fledge at 32-40 days, and post-fledging dependence lasts approximately 4 weeks (Hector 1988). With a breeding season of 6-8 months (181-242 days) northern aplomado falcons could raise more than one brood per year. Soon after their young fledge

the parents begin to display at nest platforms, copulate, and defend their nest sites, but double-brooding has not been confirmed.

Reproductive Output

The average clutch contains 2.6 eggs (Hector 1988). Four egg clutches are uncommon. Fledging rates average 1.8 young per nesting attempt (n=11) in eastern Mexico. With lost clutches excluded, the average fledging rate was 2.1 young per nest. Nothing is known about annual variability in reproductive output, numbers of non-reproductive pairs, or post-fledging and adult survivorship. Until this information is available it will be difficult to determine if populations in eastern Mexico are self-sustaining.

Mortality Factors

These falcons are common in eastern Mexico areas heavily populated by humans and apparently are not intensively persecuted. Shooting mortality, however, may be a concern at future U.S. release sites near dove, quail, or waterfowl hunting areas. Wind storms and agricultural burning appear to be significant mortality factors in Mexico (W. Burnham, pers. communication).

Hector (1982) found botfly (Philornis sp.) parasitism in 6 nestling falcons (in two of 15 nests examined). Philornis larvae are an important cause of nestling mortality in many neotropical birds (Smith 1968), and may cause death of some young falcons.

Natural predation on falcons has not been detected in eastern Mexico. Brown jays and caracaras, however, are potential predators of eggs and

young and caracaras are also potential predators of adults. Great-horned owls and common barn-owls (Tyto alba) are predators of young falcons.

Pesticide Effects

One of the most severe threats to the species is pesticide contamination. Levels of DDE in membranes of 20 clutches of northern aplomado falcon eggs collected in Veracruz (1957-1966) averaged 297 ppm (range 110-530 ppm). Membranes of shell fragments collected in 1977 from 10 nests along a 550-mile transect averaged 296 ppm DDE (range 31-1280 ppm; Kiff et al. 1980). Kiff et al. (1980: 951-952) made the following observations about the pesticide problem. The average decrease (1954-1967) in eggshell thickness (25.4%) is particularly severe and is equivalent to the maximum amount of thinning reported for any population of peregrine falcons (Peakall and Kiff 1979). DDE residue levels found in both bat falcon (Falco rufigularis) and aplomado falcon eggs exceed those associated with 20% thinning in peregrine eggs (Peakall and Kiff 1979). As noted by Peakall et al (1975), thinning of over 20% is likely to result in reproductive failure, primarily from egg breakage.

These findings indicate the need for a population-wide survey of the effects of pesticide contamination on aplomado falcons. Experiences with similar pesticide-sensitive species suggest that productivity of falcons in eastern Mexico is threatened by DDT-related reproductive failure.

Past Research and Conservation Efforts

Pesticide-related eggshell thinning was studied 1976-77 (Kiff et al. 1980). The first ecological studies of the species were begun by Hector in

1977. To date, this work has produced descriptions of diet composition (Hector 1985), hunting behavior (Hector 1986), and habitat requirements. The species' decline in the U.S. was reviewed by Hector (1985, 1986a, 1987, 1988) and Keddy Hector (1988). Dickson and Hector (1987) produced an educational film that describes the ecology and behavior of the species in Veracruz.

In 1977, the Chihuahuan Desert Research Institute (Alpine, Texas) began a study of the effects of DDT on Mexican bird-eating raptors. As an outgrowth of this project, W.G. Hunt, J. Langford, and D.P. Hector obtained four nestling northern aplomado falcons for a breeding project. In 1978, four more birds were obtained. One falcon was eventually produced and reared by John Langford of the Institute. In 1983, the seven surviving falcons were transferred to the Peregrine Fund's facility at Santa Cruz, California. An additional falcon was provided by Mr. Gary Beeman. Although hatching success has been poor, 32 young have been reared since this project began: 2 in 1984, 4 in 1985, 5 in 1986, 6 in 1987, 8 in 1988, and 7 in 1989.

Hector examined potential reestablishment sites in Arizona, New Mexico, and Texas (Appendix) 1984-1986. In 1985, four northern aplomado falcons were released on the King Ranch, Texas, by the Peregrine Fund. Great horned owls (Bubo virginianus) killed two falcons. Contact with the other two falcons was lost shortly after release when they dispersed out of range of the telemetry receivers. Intense harassment by scissor-tailed flycatchers (Muscivora forficata) did cause early dispersal of the surviving birds. The advanced age of the nestlings at the time of their release may also have been a factor. Four nestlings were successfully

fledged in 1986 and in 1987 and five in 1988 and in 1989 by The Peregrine Fund at Laguna Atascosa National Wildlife Refuge, Texas. Aplomados are now occasionally seen on the Refuge.

Suggested Management Strategies

Information is needed on the status of the species in Mexico, including the extent to which populations are being affected by pesticides. Determining the status of Mexican populations will help us assess how urgently captive propagation and reintroduction efforts are needed.

Regardless of the status of the aplomado falcon in Mexico, an attempt should be made to establish populations in the U.S. If release sites are carefully chosen, reestablished populations should be relatively free from pesticide contamination. Releases may facilitate range expansion because pesticide contamination may have reduced the ability of most populations to colonize new patches of suitable habitat. The potential for range expansion is now more promising as a result of recent brush control efforts in southern and coastal Texas and the discontinued use of DDT. Studies of movements and behavior of recently flying birds could greatly improve our knowledge of habitat requirements, information that would be useful in selecting and managing other release sites and management areas.

There may be situations where private lands are needed to fulfill habitat requirements of aplomado falcons. In such a situation, conservation easements are to be preferred to outright land purchase. These easements will be only from willing sellers, and not based on condemnation proceedings.

Captive breeding and reestablishment efforts must address concerns of inbreeding depression and maintenance of genetic variability in all matters relating to procurement of breeding stock, pairing of breeding males and females, and selection of individuals for release at specific sites. A captive population of falcons could also be used to boost productivity of wild populations. Inbreeding may cause loss of vigor and fertility and reduced ability of the population to adapt to environmental change. There may be an increased expression of lethal recessive genes and other consequences of inbreeding depression as heterozygosity decreases (Crow 1986). Although the deleterious effects of severe inbreeding have been well known for some time, this topic has recently been emphasized by conservation biologists (Slatis 1960, Corbin 1978, Denniston 1978, Lovejoy 1978, Seal 1978, Benirschke et al 1980, Senner 1980, Soule 1980).

The deleterious consequences of inbreeding depression in small populations of normally outbreeding organisms have been well documented (McPhee et al. 1931, Tinkle and Selander 1973). However, there is still no clear consensus about how large a population must be to maintain sufficient genetic variablilty for adapting to changing environmental conditions or how inbreeding affects raptors (Dawson et al. 1987). One accepted population guideline is Franklin's (1980) 50/500 rule which says that an effective breeding population (N_e) of 50 animals is necessary to maintain short-term genetic variability, and an N_e of 500 is required to maintain long-term a high degree of genetic variability. The applicability of this "rule" to populations of falcons is unknown. One can only state with confidence that falcon populations should be as large and genetically diverse as possible.

Simultaneous to the reintroduction work, suitable habitat in the U.S. and Mexico should be identified and protected, especially in areas close to reintroduction sites. Particular attention should be directed toward suitable habitat on public lands.

Release populations should be considered for designation as "experimental populations" under Section 10(j) of the Endangered Species Act. For the purpose of Section 7 of the Endangered Species Act, an experimental nonessential population is treated like a species proposed for listing. The experimental population designation will eliminate any potential detrimental economic impacts on private landowners who might otherwise be required to alter their management practices to avoid "take".

Public hearings will be held in the potential release areas to identify public attitudes about release activities. Priority will be given to releases in areas where there is strong public support for the reintroduction and where there are minimum opportunities for public conflicts with the release. Priority will also be given to releases on large areas of suitable habitat within public lands.

Finally, efforts must be made to restrict use of DDT and other contaminants within the falcon's geographic range. For the Environmental Protection Agency pesticide management purposes, application of problem pesticides will only be prohibited on Laguna Atascosa National Wildlife Refuge and bordering private lands in 1990 (Figure 5). These restrictions can be modified annually as changes occur in occupied habitat. Education of the general public, including farmers, ranchers, hunters, school children, and members of conservation groups, concerning the biomagnification of environmental contaminants, predator-prey

biomagnification of environmental contaminants, predator-prey relationships, and natural history of birds of prey will also be an effective means of reducing the use of non-specific chemical pesticides.

PART II - RECOVERY STEP-DOWN OUTLINE

Objective

To ensure that the northern aplomado falcon is no longer threatened by habitat loss, pesticide contamination, or human persecution. Immediate and careful implementation of this Recovery Plan could lead to downlisting this subspecies from the Endangered category to Threatened within 2-4 decades. However, it is inappropriate to designate delisting criteria at this time. Delisting criteria may be determined after research identifies the quantity of suitable habitat and other unknown factors. The criteron for downlisting to Threatened status has been tentatively identified as a minimum self-sustaining population of 60 pairs in the United States (this goal might be modified after we learn more about suitable habitat in the United States).

Step-Down Outline

1. Evaluate, monitor, and minimize all threats including pesticides (and other contaminants) to extant populations.
   11. Determine the distribution and size of populations.
   12. Monitor fledging success and investigate population dynamics of these falcons in eastern Mexico.
   13. Determine the degree of shell thinning and levels of pesticide contamination.
   14. Monitor residue levels in prey species and identify principal sources of contamination.
   15. Reduce contaminant levels in the food of aplomado falcons.

2. Identify, maintain, and improve habitat.
   21. Identify the habitat requirements of northern aplomado falcons in Mexico.
   22. Locate areas of suitable habitat for aplomado falcons.
   23. Protect habitat.
      231. Influence management of key habitat areas.
   24. Maintain and improve habitat.
      241. Control brush encroachment.
      242. Protect and maintain appropriate ground cover.
      243. Increase small bird abundance.
      244. Protect and enhance perch and nest trees.
      245. Establish artificial nesting platforms.
      246. Support populations of nest-building birds.
3. Reestablish the northern aplomado falcon in the U.S. and Mexico.
   31. Evaluate potential release sites.
   32. Prepare sites for release of nestlings.
      321. Minimize losses of falcons to predators.
   33. Develop a breeding management plan for maintenance of a genetically diverse captive population.
   34. Develop release techniques and conduct releases.
   35. Conduct follow-up studies of survival, hunting success, and habitat selection of released falcons.
      351. Adequately mark released falcons.
      352. Radio-tag and monitor selected falcons.
      353. Determine habitat selection of released birds.
   36. Assist artificially established populations.

37. Monitor and reduce harmful levels of pesticides in released falcons and their prey.

4. Conduct studies of habitat requirements, physiological ecology, and behavior of wild falcons.

41. Study juvenile dispersal and seasonal movements of adults.

42. Refine knowledge of nest platform requirements.

43. Evaluate and minimize human disturbance at nests.

5. Enhance public support for this recovery effort through educational programs.

51. Prepare educational materials.

52. Distribute educational materials.

53. Give oral presentations.

6. Encourage national and international cooperation and coordination in carrying out these objectives.

61. Promote exchange of information between involved government agencies, non-government organizations, and biologists.

62. Develop and implement effective international habitat protection and law enforcement efforts.

Recovery Narrative

Prior to 1947, the major threat to the northern aplomado falcon was loss of habitat to agricultural development and brush encroachment. Recently, however, pesticide contamination has become a more serious threat. Captive propagation and establishment of this falcon in the U.S. and Mexico is needed to encourage recolonization of suitable habitat. Ultimately, the preservation of this species depends on: (1) regulating the use of any pesticides found to be harmful to the falcon or its prey, and (2) using habitat management techniques that protect and restore healthy grassland ecosystems.

Recovery Outline

1. Evaluate, Monitor, and Minimize All Threats Including Pesticides (and Other Contaminants) To Extant Populations

The current status of the northern aplomado falcon is poorly known. The size of extant natural populations and threats to them have not been studied. Along with habitat loss, evidence strongly implies that this falcon is threatened by pesticide-induced reproductive failure (Kiff et al. 1980, Hector 1985). Unfortunately, there are no recent data on pesticide levels in wild populations. Furthermore, there is no quantitative information on the extent to which pesticide contamination is affecting reproductive output and adult mortality rates. Such information is needed to assess the urgency of captive breeding/reestablishment programs as a means of sustaining this subspecies. Attempts to mitigate the impacts of pesticides must be encouraged because the evidence is overwhelming that organochlorine pesticides, in particular DDT, disrupt the reproductive biology of upper trophic level birds, especially of bird-eating falcons (Newton 1979).

11. Determine the Distribution and Size of Populations

Before it is possible to assess threats to the northern aplomado falcon, its distribution and abundance must be investigated in Mexico. Recent surveys of central and western Mexico detected no aplomado falcons (Hector 1986b). Additional surveys, however, should be conducted in

northeastern Mexico (Tamaulipas, Nuevo Leon, San Luis Potosi, and Coahuila), as well as the northern part of the Yucatan peninsula (Yucatan and Campeche) to determine not only the present northern limit of the subspecies' distribution, but also areas where the northern aplomado falcon may still be common.

12. Monitor Fledging Success and Investigate Population Dynamics of These Falcons in Eastern Mexico

In accordance with the criteria for downlisting, an initial study of the population biology of northern aplomado falcons should be carried out in Mexico. The objectives are to determine the status and population trends, including estimates of hatching and fledging success, adult and juvenile mortality, and causes of any losses.

It is very important to determine annual productivity and adult mortality, as well as the extent to which productivity varies between years, among pairs, and among pairs containing different levels of pesticide residues. The ultimate objective must be to determine the health of the population and to apply this information to management practices within the United States.

13. Determine the Degree of Shell-Thinning, and Levels of Pesticide Contamination

Collect addled eggs and shell fragments. Measure shell thicknesses, and derive Ratcliffe Indices (Ratcliffe 1980) for eggs. Use applicable techniques to measure levels of DDT in

shell membranes. Compare these levels with pre- and post-DDT eggs analyzed by Kiff et al. (1980). Trap adult falcons and collect blood samples so that blood residue levels can be analyzed. Examine correlations between blood residue levels, hatching and fledging success, and patterns of adult mortality. Look for trends of increasing or decreasing pesticide-related effects.

14. Monitor Residue Levels in Prey Species and Identify Principal Sources of Contamination

Collect samples of typical prey at falcon nesting territories to determine levels of DDE, dieldrin, PCBs, and heavy metals. Residue levels in prey should be compared among different areas with the productivity of local nesting falcons. Sampled prey species should include permanent residents and transients to determine the source of pesticide contamination. If permanent residents carry heavy loads and are frequently eaten by falcons, it will be important to determine the types and amounts of pesticides applied to local crops.

15. Reduce Contaminant Levels in the Food of Aplomado Falcons

Determine the extent to which pesticides (DDT, dieldrin, and any other compound that is injurious or degrades into compounds injurious to falcons) are applied in the U.S. and Mexico in areas inhabited by falcons or their prey. Initiate efforts to reduce chronic, sublethal contamination and acute poisoning of falcons.

2. Identify, Maintain, and Improve Habitat

The ultimate objective is to protect and to "seed" suitable patches of coastal prairie and desert grassland with northern aplomado falcons, and maintain these habitats in a condition suitable for continued occupancy. Currently, data are lacking on the habitat requirements of aplomado falcons, especially in desert grassland areas.

21. Identify the Habitat Requirements of Northern Aplomado Falcons in Mexico

Keddy Hector (1988) presents the only information available concerning the habitat needs of northern aplomado falcons. Additional quantitative data are needed on spatial requirements, variation in habitat structure, plant species composition and diversity, avian species diversity, abundance, and composition in areas occupied by the falcons. Such information is especially needed in interior grassland areas to help restore and maintain suitable habitat and evaluate and prioritize potential sites for reestablishment.

22. Locate Areas of Suitable Habitat for Aplomado Falcons

Determine how much land in Mexico and the U.S. is currently suitable for occupancy by aplomado falcons and the rate at which available habitat is changing. Continue to identify and prioritize areas suitable for reestablishing falcons. LANDSAT imagery in combination with ground surveys may be the most efficient approach to accomplish these objectives. Knowledge of the amount and location of available desert grassland and

coastal prairie will help to identify release sites and may lead to the discovery of unknown populations.

23. Protect Habitat

A combination of the methods described below should be used to protect enough habitat in the U.S. for long-term maintenance of several aplomado falcon populations, totaling at least 60 breeding pairs. After key habitat units have been identified, it may be necessary to influence management on some of these sites or to develop management agreements so falcon habitat can be maintained and enhanced.

231. Influence Management of Key Habitat Areas

Through long-term cooperative arrangements, leases, exchanges, or purchases, and conservation education programs, protect surviving expanses of grassland. The most efficient approach to habitat management generally is to promote progressive range management techniques among owners of large expanses of grassland and coastal prairie habitat.

24. Maintain and Improve Habitat

Aplomado falcons prefer areas with widely scattered trees and relatively low ground cover. Management sites, therefore, should be kept relatively open through the use of appropriate range management techniques.

241. Control Brush Encroachment

Burning, root plowing, or chaining of woody vegetation may be necessary to restore grassland in areas where

brush has encroached. The goal is not eradication of woody plants, but rather the reduction of woody vegetation density and the creation of open areas. The open areas could either be fields containing only a few trees or open parklands with scattered trees. Fields should be in blocks of at least 80 ha (200 acres) (Hector 1988) to be suitable falcon hunting areas. Brush control must be carefully planned to avoid conflicts with conservation and management of ocelot.

242. Protect and Maintain Appropriate Ground Cover

Ground cover should be managed to provide near-optimal conditions for prey species and good hunting opportunities for falcons. Generally, 80% of the herbaceous ground cover should be no taller than 50 cm (Keddy Hector 1988).

It is not necessary to exclude cattle and other herbivores from management sites. Grazing, along with other management techniques, should be carefully considered as a tool to promote habitat heterogeneity and prey species diversity and abundance. Grazing programs must be carefully managed so they will not destroy ground cover and cause proliferation of brush.

Light grazing pressure, mowing, and burning should help improve prey species abundance and diversity. Prescribed burns, if properly managed, should slow the encroachment of woody vegetation and create ideal hunting areas for

falcons. Prescribed burns should not occur during nesting periods. In areas where prescribed burns are not feasible, alternative means should be used to promote favorable ground cover diversity and prey abundance, and to retard the spread of woody vegetation.

243. Increase Small Bird Abundance

Procedures that increase the abundance of small birds should be encouraged. Promote seed-eating species because granivorous birds are likely to carry lower levels of persistent organochlorine pesticides than insectivorous birds.

244. Protect and Enhance Perch and Nest Trees

In areas where few trees are present, isolated cottonwoods, mesquite, and shrubs should be protected. Suitable nest tree species should be planted as needed.

245. Establish Artificial Nesting Platforms

One means of improving habitat quality is construction of artificial nesting platforms. The ideal platform should be no wider than 50 cm to dissuade large raptors, such as great horned owls, from occupying them.

246. Support Populations of Nest-Building Birds

Populations of Chihuahuan ravens, Swainson's hawks, black-shouldered kites, and white-tailed hawks should receive special protection and support because aplomado falcons will likely depend on these species for nesting platforms.

3. Reestablish the Northern Aplomado Falcon in the U.S. and Mexico

Begin efforts to reintroduce the falcon to suitable habitat in the U.S. and other parts of Mexico using captive-produced falcons or nestlings from Mexico.

31. Evaluate Potential Release Sites

Preliminary efforts have been made to identify management areas in the United States (Appendix). Additional study on these sites and searches for other suitable sites are needed. The pesticide loads carried by the principal prey species of northern aplomado falcons should be measured at release areas. Release activities should be conducted outside of the more heavily contaminated areas. Release areas should be selected to maximize survival of released falcons and opportunities for breeding and successful rearing of young. Sites containing a large amount of protected suitable habitat, and abundant, clean prey resources should be given the highest priority for reestablishing aplomado falcons.

Although it may be unreasonably restrictive to limit management activities to areas large enough to support a large number of breeding pairs, sizable areas are certainly more desirable than smaller sites. We have no reliable data on the spatial requirements or dispersal distances of aplomado falcons, consequently it is difficult to estimate how large a management area must be, or how many pairs it will support. Based on the spacing of falcons in eastern Mexico, and data from other Falco species, home range size per pair might range

from 300-3400 ha (740-8500 acres). Assuming a home range size of 5000 acres per pair, a series of management areas (within 100 km of each other) totaling 120,000 ha (300,000 acres) would contain space for the home ranges of 60 pairs of falcons.

Although the northern aplomado falcon is a grassland/savanna inhabitant, the best habitat for the species is not necessarily a homogeneous expanse of grassland or savanna. Aplomado falcon habitat in eastern Mexico contains a mixture of open pasture with scattered trees, dense brushy woodlots, farmlands, marshes, meandering streams, and stock ponds. Release sites should be predominately grassland, but also desirable is grassland with scattered trees or shrubs and patches of other plant associations that provide nesting or feeding habitat for falcon prey.

Proposed potential U.S. "core areas" (see Appendix) for reestablishing aplomado falcons should be revised after additional surveys are conducted in the U.S. and Mexico. Small bird surveys, more precise determination of the spatial requirements of nesting falcons, and more precise estimates of the coverage of various plant associations are needed to prioritize sites for release. Input from state wildlife agencies and federal land management agencies will also be important.

The impact on other endangered species is another factor that must be considered at any potential release site. For

example, sites managed primarily for Attwater prairie chicken (Tympanuchus cupida attwateri) or masked bobwhite quail (Colinus virginianus ridgwayi) may be inappropriate for releasing falcons. Recovery teams for the other species should be consulted before any hacking is planned.

32. Prepare Sites for Release of Nestlings

Visit release sites to decide on specific locations for hackboxes. Areas containing high densities of great horned owls and barn owls should be avoided. To slow dispersal of birds during early stages of the release, the best possible release sites should be utilized. Landowners of adjacent properties should be contacted to obtain permission to recover any falcons that prematurely stray from the release site.

321. Minimize Losses of Falcons to Predators

Great horned owls and other predators are likely to be an important factor at some sites. It may be necessary to regulate local owl populations to protect the released birds.

33. Develop a Breeding Management Plan for Maintenance of a Genetically Diverse Captive Population

Captive falcon populations should be maintained in a way that minimizes inbreeding (Wright 1921, Flesness 1977, Seal et al. 1977).

34. Develop Release Techniques and Conduct Releases

The basic procedures developed for the release of captive-bred peregrine falcons are a good starting point, but they

should be adjusted to reflect the behavioral, morphological, and ecological differences existing between peregrines and aplomado falcons.

35. Conduct follow-up Studies of Survival, Hunting Success and Habitat Selection of Released Falcons

Do follow-up work with released falcons to refine techniques and ecological data. It is extremely important to determine how released aplomado falcons survive. Released falcons should be relocated and observed throughout the year. This may require the use of radio transmitters on a few released falcons. It will not be sufficient simply to search for birds returning during the breeding season.

351. Adequately Mark Released Falcons

Band released birds so that the site and year of release can be identified for recovered or relocated birds. Released birds must be marked so they are individually identifiable and, if possible, visual sightings can be used to monitor their wanderings. Extremely visible marking devices such as patagial markers should be avoided because they might increase the falcons susceptibility to shooting.

352. Radio-tag and Monitor Selected Falcons

Use radio transmitters to gather information on the movements and behavior of released falcons, and to

provide a means of finding birds on potential breeding territories.

353. Determine Habitat Selection of Released Birds

Areas selected by released falcons as wintering and nesting sites should be evaluated quantitatively. The behavior of the falcons using these areas should be studied to provide additional data on habitat preference. Conclusions resulting from such efforts will help to refine reintroduction site criteria and habitat management procedures.

36. Assist Artificially Established Populations

After releases have begun at a site, they should continue until that site is either judged to be unsuitable for habitation, or becomes saturated with nesting falcons. Release in areas greater than 100 km from the initial release site should not be attempted until sufficient release stock is available. Attempts should be made in January-April of the years following release to locate birds surviving from previous years. Nesting platforms should be placed in release areas in the months following the initial releases. Locations of artificial platforms should be recorded along with locations of any natural stick platforms so that these areas can be systematically checked for nesting falcons.

37. Monitor and Reduce Harmful Levels of Pesticides in Released Falcons and their Prey

Continue monitoring pesticide levels in prey species at release sites. Begin monitoring levels of contamination in falcons and their eggs when they begin to breed in these areas. If deemed necessary, attempt to reduce levels of pesticides in the food chains of these falcons.

4. Conduct Studies of Habitat Requirements, Physiological Ecology, and Behavior of Wild Falcons

Additional studies of geographic variations in ecological, behavioral, and physiological requirements of this falcon should be accomplished so we will understand the extent to which northern aplomado falcons from a single population are able to tolerate variations in habitat and climate.

41. Study Juvenile Dispersal and Seasonal Movements of Adults

It is important to know where first-year birds go after fledging. Falcons (n=10) collected in western Mexico were taken in winter months (museum specimen records). Grayson (in Lawrence 1874) reported no falcons in the vicinity of Mazatlan during the spring or summer. Grayson's observations as well as a sighting of four northern aplomado falcons moving steadily northward along the coast of eastern Mexico March and April 1977, (Hector, pers. observations) suggest that at least some members of the northern subspecies may be migratory. It is important to learn whether birds released in the U.S. show any tendency to move south for part of the year. Such movements may increase the exposure of

birds to pesticide contamination and partially defeat the purpose of reintroduction efforts.

42. Refine Knowledge of Nest Platform Requirements

Collect additional measurements of falcon platforms and brood sizes. Determine whether nesting platform size is correlated with brood size. Build prototype models of artificial nesting platforms. Place these models on nesting territories of falcons in Mexico. Monitor occupancy rates for each model. Determine which design is most feasible in terms of attractiveness to falcons, durability, and expense.

43. Evaluate and Minimize Human Disturbance at Nests

Identify human disturbances which adversely affect nesting falcons. It will be important to determine how close researchers can approach without disrupting the normal activities of falcons. In Mexico, falcons appeared to be undisturbed even when observers approach within 100 m. This distance seemed to apply to breeding adults, non-breeding adults, and immatures (Hector, pers. observations). Ligon (1961) recorded similar observations of falcons in southern New Mexico. These behavior patterns suggest that released falcons could be approached rather closely without causing detrimental results. Close approach, however, may not be advisable because falcons may habituate to the presence of humans and thereby become more susceptible to shooting mortality.

5. Enhance Public Support for this Recovery Effort through Educational Programs

Members of the general public, local government officials, and concerned scientists in Mexico and the United States should be informed about the species

51. Prepare Educational Materials

Prepare films, slide shows, pamphlets, and other materials, in Spanish and English, that give details on the identification, natural history, and conservation needs of falcons.

This work began in 1987 with the creation of a short (15-minute) educational film on the hunting behavior of the aplomado falcons of Veracruz (Dickson and Hector 1987). Copies of this film can be purchased through the Office of Instructional Development of the University of California System (Berkley and Los Angeles). A Spanish version of this film should be developed for use in Mexico.

52. Distribute Educational Materials

Distribute educational materials among appropriate primary, secondary, and post-secondary level instructors in the U.S. and Mexico. Provide identification pamphlets to the general public, local hunters, wildlife managers, and enforcement personnel. Promote additional dissemination of information by preparing frequent press releases for newspapers near sites of management activities.

53. Give Oral Presentations

Give presentations to conservation organizations, sportsmens' clubs, hunter safety classes, farmers' and ranchers' organizations, and other interested groups.

6. Encourage National and International Cooperation and Coordination in Carrying Out These Objectives

The procedures described in the Recovery Plan Narrative cannot be accomplished without the participation and cooperation of various government agencies, range and wildlife managers, and other technical experts in Mexico and the U.S.

61. Promote Exchange of Information Between Involved Government Agencies, Non-governmental Organizations, and Biologists

Reports of progress and new developments must be circulated among all participating agencies and research specialists in Mexico and the U.S. Prompt distribution will ensure that all project participants will be quickly apprised of new developments regarding success or failures of management techniques, significant research advances, or any additional information of management significance.

Participating agencies should coordinate their funding of research and management efforts in order to avoid redundancy in these activities. Whenever possible the services of appropriate specialists should be solicited to ensure that procedures are implemented and information collected as efficiently as possible. Cooperative research endeavors should be encouraged on an interagency or international basis.

62. Develop and Implement Effective International Habitat Protection and Law Enforcement Efforts.

Through cooperation with federal, state, and local authorities, strengthen law enforcement provisions aimed at reducing the killing, capture, or trade of aplomado falcons.

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Part III. IMPLEMENTATION SCHEDULE

General Category	Plan Task	Task Number	Priority	Task Duration (Years)	Responsible Parties*	Fiscal Year Costs (Thousands of dollars) 1	2	3
I1	Determine population status	11	2	3	FS, RS		40	40
R6	Monitor population productivity and dynamics	12	2	Ongoing	"		60	60
R12	Monitor contaminant levels in eggs and falcons	13	2	Ongoing	"			5
R12	Monitor contaminant levels in prey and identify sources of contamination	14	2	Ongoing	"		15	15
I12	Reduce pesticide levels in prey	15	1	Ongoing		50	50	50
R3	Identify habitat requirements	21	1	3-5	"	20	25	30
I2	Locate suitable habitat	22	2	Ongoing	Tx,NM,AZ, BLM,RS,NPS, USFS	20	20	
M3	Protect habitat	23	1	Ongoing	"	10	10	10
M3	Maintain habitat	24	2	Ongoing	"			

Part III. IMPLEMENTATION SCHEDULE

General Category	Plan Task	Task Number	Priority	Task Duration (Years)	Responsible Parties*	Fiscal Year Costs (Thousands of dollars) 1	2	3
M2	Evaluate release sites	31	2	2	"	5	5	
M2	Prepare release sites	32	2	Ongoing	"			2
M1	Develop breeding management plan	33	1	Ongoing	PF	no new $		
M1	Conduct releases	34	1	Ongoing	PF, RS			15
I13, I3	Follow-up studies	35	2	Ongoing	PF,AZ,TX, NM,RS			
M2, M3	Assist new populations	36	2	Ongoing	"			
I12	Monitor pesticides in released birds	37	2	Ongoing	"			
R8	Study seasonal movements & nest platform requirements	41,42	2	Ongoing	"			10
O2	Protect nests	43	2	Ongoing	"		no new $	

Part III. IMPLEMENTATION SCHEDULE

General Category	Plan Task	Task Number	Priority	Task Duration (Years)	Responsible Parties*	Fiscal Year Costs (Thousands of dollars) 1	2	3
01	Educational Work	5	3	Ongoing	FS,ES			

* Within the United States, the Fish and Wildlife Service, Region 2, Fish and Wildlife Enhancement Division will have the lead role for coordination. Others include: TX=Texas Parks & Wildlife Dept., NM= New Mexico Dept. of Fish and Game, AZ= Arizona Dept. of Game & Fish, BLM= Bureau of Land Management, FS= Dept. Flora y Fauna Silvestre, Mexico, RS= Raptor Specialists, ES=Educational Specialists, GS=Genetic Specialists, PI=Private Institutions.

APPENDIX

DESCRIPTIONS OF SOME POTENTIAL RELEASE SITES

Release/management sites were visited between December 1985 and June 1987. Individuals responsible for the management of each site were interviewed to determine whether release would be feasible. This list is not all inclusive. Other potential release sites are not listed here because they were not surveyed.

ARIZONA:

Buenos Aires NWR. Located in central Arizona in Altar Valley, this 44,400 ha (111,000 acres) refuge extends north from the Mexican border. It is basically a large expanse of excellent mesquite grassland. The primary purpose of this refuge is restoration of masked bobwhite to the U.S. Although aplomado falcons do capture bobwhites in eastern Mexico, they capture quail infrequently, even in areas where they are abundant (Hector 1985). Consequently, it is unlikely the presence of aplomado falcons on this refuge would pose a significant threat to quail populations. Any falcon releases proposed for this site should be reviewed by the masked bobwhite recovery team.

Elgin Research Ranch. This 3,160 ha (7,900 acres) owned by the National Audubon Society in southeastern Arizona near Elgin is excellent habitat. It is a lush desert grassland with a well developed strand of oak woodland in the valley bottoms. Scattered mesquites are present on the mesas and slopes.

Ft. Huachucha Military Reservation. This military base contains 31,400 ha (78,500 acres) in southeastern Arizona. It contains much mesquite and oak grassland, but in general the habitat is structurally poorer than on the Research Ranch. Releases could be carried out along some of the open draws in the northern half of the installation.

San Pedro Riparian National Conservation Area. Located in southeastern Arizona, this 20,000 ha (50,000 acres) refuge is recently established by the Bureau of Land Management. It is essentially a narrow riparian corridor which extends north from the Mexican border. Northern portions of this refuge are bound by creosote flats and mesquite-encroached floodplains. Some potential release sites, however, might be located to the south, near the Mexican border. Much of this land is publicly owned and would be available for release activities. Continued acquisition of grassland to the north should steadily improve the quality of this site. Although aplomado falcons apparently did inhabit gallery woodlands (Grayson in Lawrence 1874, Henshaw 1875), initial releases should be accomplished in grassland sites.

San Simon Valley. Located north of Chiricahua Mountain, this 30,400 ha (760,000 acres) huge yucca-grassland is an ideal release area in terms of habitat quality.

Santa Rita Experimental Range. This site of 21,200 ha (52,500 acres) is in south-central Arizona southeast of Tucson. Only about 10% is open grassland, but additional acreage is partly open with scattered mesquite. Releases would provide valuable information on the ability of aplomado falcons to survive in brushier habitats.

Willcox Playa Wildlife Area. Located in southeastern Arizona, this site contains less than 400 ha (1,000 acres). Although it contains the least amount of suitable habitat, it is adjacent to an extensive yucca grassland community,

NEW MEXICO:

Gray Ranch (proposed Animas NWR): This site is in southeastern New Mexico and contains 130,191 ha (321,703 acres). It includes extensive grasslands with a distinct desert influence at lower elevations. Bird life is abundant (43% of New Mexico's avian species) and would provide an excellent prey base for the aplomado falcon.

White Sands Missile Range. The range is in central New Mexico and contains one million ha (2.5 million acres). The northwest corner (200,000 acres) is excellent yucca/grassland. There is presently no livestock grazing and no public access to this area.

TEXAS:

Aransas National Wildlife Refuge. Located on the middle coast, this 22,000 ha (55,000 acres) "site" contains much suitable habitat on the Tatton Unit, a 3,027 ha (7,568 acres) pasture that presently supports white-tailed hawks and prairie chickens. Much of the remainder of this refuge is dense oak woodland and coastal marshes. Primary management concerns at this refuge are the whooping crane, white-tailed deer, and Attwater's prairie chicken. Crane and prairie chicken management practices, however favor prescribed burning and would partly fulfill the management needs of aplomado falcons. Aransas NWR seems ideal habitat in most respects.

Elephant Mountain Wildlife Area: Located in the Trans-Pecos south of Alpine, this 9,200 ha (23,000 acres) refuge's primary purpose is management of desert bighorn sheep. It is used as a public hunting area during the fall, however, hunting is tightly regulated. Much of this area is degraded rangeland, but one 10,000 acre grassy basin is suitable for the falcons.

Laguna Atascosa NWR: This refuge contains 16,000 ha (40,000 acres) located on the lower coast. In the past, this refuge has emphasized management of waterfowl and upland gamebirds. More recently, however, ocelot management has been emphasized. Laguna Atascosa contains a mixture of coastal prairie and tidal flats. White-tailed hawks nest there so it is likely that habitat structure is appropriate for aplomado falcons.

The King Ranch: Located on the coastal bend from Kingsville south, this 320,000+ ha (800,000+ acres) property is owned by King Ranch Corporation. This huge ranch contains a large amount of coastal brush-grassland, and aplomado falcons occurred here in the early 1950's. This site supports extremely high densities of white-tailed hawks, Harris' hawks, and caracaras. This is undoubtedly the best release site available in terms of habitat quality and quantity.