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In response refer to:
AESO/ES:
2-21-94-F-066

June 6, 1994

MEMORANDUM

TO: Refuge Manager, Buenos Aires National Wildlife Refuge, Sasabe, Arizona

FROM: State Supervisor

SUBJECT: Biological Opinion on the Proposed 1994 Prescribed Grassland Burning on Buenos Aires National Wildlife Refuge

This biological opinion responds to your request dated April 8, 1994, for formal section 7 consultation pursuant to the Endangered Species Act (Act) of 1973, as amended, on the 1994 prescribed burning program on the Buenos Aires National Wildlife Refuge (Refuge). The 90-day formal consultation period began on April 12, 1994, the day your request was received at the U.S. Fish and Wildlife Service (Service) Arizona Ecological Services State Office (AESO).

Two endangered species are addressed in this biological opinion: the masked bobwhite quail (Colinus virginianus ridgwayi); and the Pima pineapple cactus (Coryphantha scheeri var. robustispina). No proposed or designated critical habitat will be affected by the proposed action.

This biological opinion was prepared using information from the November 2, 1993, Refuge's 1994 Prescribed Burning Program Biological Assessment (BA) and Intra-Service Section 7 Biological Evaluation Form (BE) (U.S. Fish and Wildlife Service 1993a) provided by the Refuge, a memorandum of March 28, 1994, from the Refuge Manager to the State Supervisor that provided additional data and descriptions of the proposed action, information from previous consultations on these species, data in the AESO files, published literature, and a field evaluation and meeting of Refuge and AESO personnel on May 12-13, 1994. Additional information was obtained through discussions with species experts and other knowledgeable individuals.

Biological Opinion

This biological opinion states that the proposed 1994 prescribed burning program on the Refuge, as described in the November 2, 1993, Biological Assessment, and memorandum of March 28, 1994, is not likely to jeopardize the continued existence of the masked bobwhite quail or Pima pineapple cactus.

Background Information

Description of Proposed Action

The following summary of the proposed action is drawn from project descriptions in the 1994 Prescribed Burning Program BA and BE and accompanying maps, from the memorandum of March 28, 1994, and from discussions with Refuge personnel. The proposed action is to implement a one-year burning plan to accomplish two objectives: 1) to alter grassland habitats to improve the survival of reintroduced masked bobwhite quail; and 2) to improve grasslands by reducing stands of Lehmann's lovegrass (*Eragrostis lehmanniana*), removing subshrubs, and curtailing mesquite invasion.

The Refuge is located in the Altar Valley, southwest of Tucson, Pima County, Arizona. The proposed project is to burn approximately 3,551 acres of grassland habitat within three burn units, identified as burn units 4, 10 and 12 (see map included with Refuge's 1994 Prescribed Burning Program Biological Assessment). Burn unit 4, named Secundino, includes 1,630 acres primarily within sections 13 and 24, T20S, R8E. Burn unit 10, named Airport, includes 741 acres approximately centered at the common corners of sections 15, 16, 21 and 22, T21S, R8E. Burn unit 12, named Compartidero #2, includes 1,180 acres within section 9 and portions of sections 4 and 16, T22S, R8E. These areas have been selected for prescribed fire by Refuge personnel based on the results of data on vegetation stand characteristics collected as part of the burn unit site evaluation procedures.

The proposed prescribed fires are planned for June 1994. Standard prescribed burning prescriptions will be followed in regard to air temperature, wind speed, relative humidity, cloud cover, and fire intensity. Burn units are delineated by existing roads and washes, which function as firelines. Existing roads will be graded to remove fuels, and backfires may be used as appropriate.

	Burning Prescription		
	Low	Mid	High
Air Temperature (°F)	70	85	95
Wind (@ 20 feet)	10	15	20
Relative Humidity (%)	5	10	25
Cloud Cover (%)	0	<50	50+

Burns will be conducted so that accidental burning of non-prescribed areas and burning of man-made structures would be prevented. Backfires would be used to control the intensity of head fires when appropriate. Mowed lines, roads and natural topography along the perimeter of proposed burn areas would contain the burns to the designated areas. Fire crews using appropriate fire control equipment would insure to the greatest extent possible that fires would not escape the prescription boundaries. After the fires, burned areas would be patrolled until the threat of escape is deemed unlikely.

Prescribed burns are designed to target bottomland/wash bottom areas, which are preferred foraging habitat of masked bobwhite quail. Fires are to stimulate the production of high quality quail forage of both forbs and invertebrates. Fires are also to open up the ground level vegetation which enhances visual orientation of quail to maintain the integrity of the broods. Burn areas are selected as release sites for the foster reared broods. Masked bobwhite quail may preferentially utilize the areas following a burn for one to several years (U.S. Fish and Wildlife Service 1993a).

All Refuge personnel are familiar with the identification of Pima pineapple cactus and look for it while conducting other regular Refuge duties. Surveys for Pima pineapple cactus occur during the data collection for the burn unit site evaluation, and as part of the surveys for masked bobwhite quail in the burn unit. Species specific surveys for Pima pineapple cactus are prioritized on the basis of potential habitat. Areas determined to have the best probability of occurrence within the burn unit (in the vicinity of known plants, along ridges, etc.) will be surveyed at levels greater than other areas. Within the Refuge, Pima pineapple cactus are not known to occur within bottomland/wash bottom habitats. Overall, 10 to 15 percent of the burn unit will be surveyed, with efforts concentrated in areas where there is the greatest likelihood of locating cacti (U.S. Fish and Wildlife Service 1993a).

All known Pima pineapple cactus located within a burn unit will be protected from direct impact by fire. A variety of techniques may be used including: deferral of Pima pineapple cactus habitats from fire; devices used as fire shields; backfires; removal of surrounding vegetation by mowing or weed whacking; or other methods determined to be appropriate for the site by Refuge personnel. Refuge personnel will determine the most appropriate method to be employed at any site. All known Pima pineapple cactus on the Refuge are monitored and a cactus data form is completed. The presence and condition of each plant within a burn unit will be documented prior to and following the prescribed fire.

Species Description and Status--Masked Bobwhite Quail

Masked bobwhite quail are sexually dimorphic birds. The male's head is cinnamon colored on top, as are its breast and underparts; the throat is black, a white eye-stripe is rather variable, and some males may have white at the throat. The flanks of the female are striped in a mottled reddish-brown, and the face pattern is buffy. Both sexes have a short, grayish tail.

The masked bobwhite quail was first described by Brown (1884). It is now classified as one of five bobwhite subspecies found in the United States and Mexico. It once occurred throughout much of the grassland savannas of extreme southern Arizona and Sonora, Mexico (Coues 1903 in Brown 1989). Within Arizona, bobwhites were collected in the Altar and Santa Cruz Valleys and reliable reports were common from up to 50 miles north of the Mexican border (Allen 1886, Brown 1885, Brown 1904, Phillips et al. 1964). In Sonora, the masked bobwhite quail was apparently quite widely distributed in the plains and river valleys between 950 feet and 4,000 feet elevation (Tomlinson 1972a). Its range extended south to Guaymas, east to the foothills of the Sierra Madres and west almost to the Gulf of California.

Excessive livestock use of Arizona's rangelands, beginning in the 1800's, contributed to the destruction of southern Arizona's grasslands (Brown 1900, Hastings and Turner 1965, Hollon 1966, and Wilson 1976 in Brown 1989). In a large part due to the impacts of livestock grazing management, the masked bobwhite disappeared from Arizona around the turn of the century (Phillips et al., Tomlinson 1972a).

Habitat destruction was not as severe in Sonora, where Ligon (1952) found several healthy populations of masked bobwhite quail as late as 1937. However by 1950, masked bobwhite habitat in Sonora had been degraded by livestock and related management activities. Bobwhite populations were in decline. No observations of masked bobwhite quail were reported again until 1964, when a team of biologists discovered a single population north of Hermosillo near Benjamin Hill (Gallizioli et al. 1967).

The decline and current plight of the masked bobwhite quail is "wholly related to livestock grazing and the consequent destruction of a fragile subtropical grassland ecosystem" (Brown and Ellis 1977, Phillips et al. 1964). The removal of grass and forb cover by livestock effectively eliminated the masked bobwhite's escape cover, food, and nesting habitat. The lack of fine fuels prevented natural fires, and in combination with fire suppression activities, provided for the invasion of woody plants. Grassland habitats were gradually altered and rendered unsuitable for masked bobwhite quail, with the reduction of native grass species, the invasion of exotic plants, and increases in the densities of shrubs and subshrubs (Tomlinson 1984).

The masked bobwhite is associated with grassy river bottoms and broad plains (Brown and Ellis 1977). Ligon (1952) summarized the bird's preferred habitat as a "...deep grass-weed habitat, a type of cover incompatible with heavy use by livestock." Studies of reintroduced masked bobwhite quail in the Altar Valley (Goodwin 1982) indicated that four factors are essential to the survival and successful reproduction of masked bobwhite quail:

1. A minimum of 15-30 percent overstory cover of shrubs or brush piles.

2. A high diversity of grasses and forbs, with a minimum of 18-20 species.

3. A minimum of standing grass crop of 397 pounds (lb)/acre and 12-15 percent grass cover.

4. A minimum standing forb crop of 265 lb/acre and 10-15 percent cover.

Goodwin (1982) consistently located reintroduced masked bobwhite quail within bottomlands of main and side drainages. When adequate overstory cover was present, grass and forb density, height, and diversity determined masked bobwhite quail presence. Areas of high vegetation diversity were preferentially selected.

Masked bobwhite quail typically spend most of the year in coveys of eight to twenty birds. Coveys typically contain an adult pair with their offspring, plus other adults unsuccessful in breeding. The covey travels, feeds, and rests as a unit, and roosts at night in a tight circle on the ground.

Masked bobwhite quail begin nesting in July with the onset of the summer rainy period. At this time coveys break up and males establish territories and begin giving the characteristic "bobwhite" call. Peak calling usually occurs in mid-August, and ends in early September (Tomlinson 1972b). Based on the nesting habitats of northern bobwhite quail in the eastern United States, it is presumed masked bobwhites build their nests under live perennial grasses (Goodwin 1982). Masked bobwhite quail broods, averaging 11 young, usually begin hatching in late July. Peak hatching would be in mid-September, when food and cover conditions are optimal (Tomlinson 1972b).

Limited information is available on the natural food habits of the masked bobwhite quail. It is believed that adults are adapted to take a wide variety of grass and forb seeds, with young chicks depending almost exclusively on insects for food (Goodwin 1982).

Simms (1989) conducted studies on reintroduced masked bobwhite quail at the Refuge. Home range, movement patterns, and habitat use were determined using radio telemetry. Average annual home range was 10.9 hectares. The majority of masked bobwhite quail moved less than 1 kilometer, though some long distance movements occurred during winter months when food resources were low.

Numerous reintroduction attempts of masked bobwhite quail to various locations in Arizona and New Mexico were made from 1937 to 1950. None of these proved successful. Further evaluations for suitable release sites identified areas within the Altar Valley. Releases of birds reared at Patuxent Wildlife Research Center into the Altar Valley occurred from 1970 to 1974, though again it did not result in establishing a population of masked bobwhite quail. Release techniques were improved during the late 1970s, when sterilized northern bobwhites from Texas were uses as foster parents to improve brood survivorship. These techniques are being used today (Dobrott 1992). The survival of released masked bobwhite quail on the Refuge have shown some positive results, though progress has been slow. Survivorship and reproductive success appears strongly correlated to summer rainfall and related production of food (forbs and invertebrates) and conditions of high humidity. Lack of winter food sources also appear to be limiting (U.S. Fish and Wildlife Service 1993b).

The status of the masked bobwhite quail in Mexico is continuing to decline to critical levels. Large scale habitat modification is occurring in masked bobwhite quail habitat in Mexico. Large areas of native vegetation are being cleared and converted to bufflegrass (*Cenchrus ciliaris*). The U.S. and Mexico are attempting some cooperative efforts for the conservation of masked bobwhite quail but the long-term results of these efforts are uncertain (U.S. Fish and Wildlife Service 1993b).

The masked bobwhite quail has been protected as an endangered species since the passage of the Endangered Species Conservation Act of 1969, which was superseded by the Endangered Species Act of 1973 and its amendments.

Species Description and Status--Pima Pineapple Cactus

Pima pineapple cactus is a hemispherical succulent plant, the adults measuring 4 - 7 inches tall and 3 - 4 inches in diameter. Each spine cluster has one strong, straw-colored, hooked central spine and six radial spines (Benson 1982). Plants can be single-stemmed or multi-headed. They also can appear in clusters that are formed when seeds germinate at the base of a mother plant or when a tubercle of the mother plant roots. The silky yellow flowers appear in mid-July with the onset of summer rains. The fruits are green, succulent, and sweet. Fruits disappear rapidly from the plant (Mills 1991). Mills (1991) believes the plants have short life spans.

Pima pineapple cactus is found between 2,300 feet and 5,000 feet elevation in Pima and Santa Cruz Counties, southern Arizona, and northern Sonora, Mexico (Phillips et al. 1981). The range extends east from the Baboquivari Mountains to the Santa Rita Mountains. The northernmost boundary is near Tucson. The southern boundary of the range is believed to extend a relatively short distance to the south into Sonora. Pima pineapple cacti grow in alluvial basins or on hillsides in rocky to sandy or silty soils in semidesert grassland and Sonoran desertscrub. The species occurs most commonly in open areas on flat ridgetops or areas with less than 15 percent slope. Accurate population density estimates are very difficult to make because Pima pineapple cactus is difficult to find in the field (Mills 1991). Dominant plant species in these habitats vary but include white-thorn acacia (Acacia constricta), desert hackberry (Celtis pallida), velvet mesquite (Prosopis velutina), burrobush (Ambrosia deltoidea), snakeweed (Gutierrezia microcephala), burroweed (Isocoma tenuisecta), Lehmann's lovegrass, and various cacti (Mills 1991).

The final rule listing Coryphantha scheeri var. robustispina as an endangered species was published September 23, 1993 (58 FR 49875). Factors which contributed to this listing included: the amount of habitat loss that has already occurred and will continue to occur throughout the range of this species; the amount of habitat modification; the sparsity of plants; the threat of illegal collection; and the difficulty in protecting an area large enough to maintain a viable population.

Construction associated with a rapidly growing human population in the Tucson-Green Valley-Nogales corridor is the most significant cause of habitat loss for Pima pineapple cactus and has resulted in direct mortality of plants. Mining has also resulted in the loss of hundreds, if not thousands, of acres of potential habitat throughout the range of this species, but especially in the Green Valley vicinity. In the future, habitat loss due to urbanization, mining, and associated activities is expected to continue and will probably increase throughout the range of this species.

Illegal collection of this species has been documented on a number of occasions. Some incidents indicate that collectors are specifically interested in taking C. scheeri var. robustispina. At other times, collectors appear to have no knowledge of the identity of the species being taken but are collecting all cacti in a general area.

Currently, most of the range of Pima pineapple cactus outside of urban areas is used for livestock grazing, as it has been for more than a century. Extreme overgrazing in combination with severe drought at the turn of the century, and some continuing livestock management practices, have significantly altered the grassland/desert scrub ecosystem upon which Pima pineapple cactus depends. Some effects of overuse by livestock include erosion, changes in hydrology and microclimate, invasion and expansion of exotic vegetation, increases in woody perennials, and shifts in density, relative abundance, and vigor of native plant species. Some range management practices, such as imprinting, chaining, ripping, and seeding of exotic grasses, have contributed to the modification or loss of habitat and/or loss of plants. Overgrazing in some areas continues today. Mills (pers. comm. 1991, Tucson, Arizona) has seen damage to Pima pineapple cactus that may have been directly caused by livestock trampling.

The introduction of non-native species has modified many southern Arizona ecosystems. Much of Pima pineapple cactus habitat was significantly altered by the introduction of Lehmann's lovegrass, an aggressive exotic introduced to the U.S. in 1930 (in Martin and Cox 1984) to provide cattle forage and control erosion. Lehmann's lovegrass out-competes native grasses and monotypic stands of Lehmann's lovegrass cover large areas of middle-elevation southern Arizona. The replacement of native grass species by Lehmann's lovegrass has resulted in a reduction in structural and spacial diversity within the grassland habitats and has altered the natural patterns of wildfire and competition for light and nutrients. These factors may have adversely affected Pima pineapple cactus. Another successful exotic grass is Mediterranean grass (Schismus barbatus), which is common in Sonoran desertscrub/grassland transition habitats. Dense stands of Mediterranean grass in desertscrub habitats contribute fine fuels that are readily flammable and carry fires in fire-intolerant desertscrub habitat. Lehmann's lovegrass and Mediterranean grass are two of many non-native species that may have significant negative effects to the natural ecosystem. The introduction of new non-native plant species to the southwestern United States is continuing. These introductions carry with them the potential for additional negative impacts.

Fire frequency, extent, and intensity regulate the structure and diversity of fire-prone communities on local, landscape, and subcontinental scales (Swetnam and Betancourt 1990). Fire suppression and exclusion have led to plant communities that are no longer in equilibrium. Re-establishment of natural fire cycles into fire-prone communities is needed but complicated by a number of factors, including permanent human occupancy of habitats, non-native plant species, and change in the structure of stands.

Reintroducing fire into grasslands at dis-equilibrium could have long-term negative effects resulting from changes in fuel characteristics.

Fire can damage epidermal and mesophyll tissue of cacti, which can cause plant mortality. Mortality rates of succulents after a fire are species- and size-specific, but usually exceed 40 percent, are rarely total, and are higher for species occurring in desertscrub than in fire-prone grasslands (Bunting et al. 1980, Cave and Patten 1984, McLaughlin and Bowers 1982, Thomas in litt. 1988, Thomas 1991, Thomas and Goodson 1991, Thomas and Goodson 1992). After initial post-burn mortality, deaths due to the effects of fire can continue for several years (see review by Thomas 1991, Thomas and Goodson 1991). Thomas and Goodson (1991) found that more than 80 percent of burnt *Coryphantha vivipara*, a species that is sympatric with *C. scheeri*, had died four years after a burn. Limited information on fire caused mortality is available for Pima pineapple cactus.

Not only can tissue damage cause death, but sexual reproduction can be temporarily or permanently reduced or terminated by fire damage. No studies have been performed that examine this response. The extent to which individual fecundity is reduced probably depends upon the extent of the fire-caused damage.

Fires can adversely affect cacti in other ways. If fire results in the loss of spines and pubescence, nighttime temperature of the stem may be reduced, leading to reduced carbon assimilation or even death (Thomas 1991). Burnt cacti may be more attractive to herbivores or more susceptible to disease (Thomas 1991, Thomas and Goodson 1991). *Ferocactus* damaged by fire on the Anvil Ranch in 1980 were subject to heavy herbivory by jackrabbits, ground squirrels, and pack rats (Hernandez in litt. 1993) the year after the fire occurred. On the Santa Rita Experimental Range, cattle, deer, and jackrabbits were attracted to burnt areas and ate essentially all prickly pear cactus (*Opuntia* sp.) within the burn. The severity of post-fire herbivory is probably correlated with the size of herbivore populations, availability of alternate herbaceous forage, and other sources of moisture for herbivores.

While many cacti die if damaged by fire, a substantial proportion of cacti within burned areas do not die (Bunting et al. 1980, Cave and Patten 1984, Maender in litt. 1993, McLaughlin and Bowers 1982, Thomas in litt. 1988, Thomas 1991, Thomas and Goodson 1991, Thomas and Goodson 1992, Robinett in litt. 1992). Damage due to fire can range from severe blackening and loss of all spines to slight discoloration. Plants that are damaged may die eventually or may re-sprout (Maender in litt. 1993, Robinett in litt. 1992, Thomas and Goodson 1991, Thomas and Goodson 1992, Warren et al. 1992). Damaged tissue quickly becomes calloused. The thick callous helps protect unarmed tissue.

Thomas and Goodson (1992) offer two hypotheses to explain how succulent populations survive fire. One hypothesis is that succulents survive fires by occurring in those areas that have insufficient fuels to carry a burn, are missed by chance, or are protected by discontinuities in fuel or topographical features. Cacti occurring in these "refugia" would escape the effects of fire. Long-term conservation of species with this strategy would depend on the availability and maintenance of these refugia. McLaughlin speculated that C. scheeri var. robustispina may employ this strategy (Warren and McLaughlin 1992). A substantial proportion of succulent species populations in southern Arizona escaped death or damage by fire because they occurred in refugia (Thomas 1991, Thomas and Goodson 1992, McLaughlin and Bowers 1982). Several observers have noted that C. scheeri occurs in open habitat patches within the grassland and desertscrub ecosystem (McLaughlin in litt. 1992, Mills 1991, Tolley 1992, Warren and McLaughlin 1992). This distribution seems to support the hypothesis that C. scheeri employs refugia to exist in fire-prone grasslands.

A second hypothesis is that cacti, particularly those that occur in fire-prone plant communities, have evolved morphological and/or physiological fire tolerances. Thomas and Goodson (1992) found that several species of southern Arizona succulents appear to have fire tolerances. Pediocactus paradinei, a cactus endemic to the Kaibab Plateau in Arizona, also appears to be tolerant of fire (Warren et al. 1992). This species can survive low intensity fires, although survivorship was low in high intensity fires. Maender (in litt. 1993) revisited an area on the Anvil Ranch that had been burned in 1991, and found that fire damage to Pima pineapple cactus plants ranged from no damage to severe damage and one plant of sixteen died. This observation and similar ones by Robinett (1992) and Tolley (1992) indicate that the species has some fire tolerance, although long-term survivorship after a burn has not been determined.

Pima pineapple cactus likely employs some combination of fire tolerance and refugia as part of its long-term maintenance in a natural grassland community. Fire could kill plants in a local area, damage plants in others, and skip over plants in other areas. Plants that occur in refugia could serve as seed sources for recolonizing severely burned areas. Whether this strategy can maintain or increase population size depends upon the rate of recruitment of new individuals, their fire differential tolerance with age, and the fire regime, including fire frequency, intensity and season (Thomas and Goodson 1992).

Since Pima pineapple cactus was proposed as endangered, the following Federal and non-Federal actions have adversely affected the species:

- An unspecified number of acres of habitat and a small number of plants have been lost in late 1993 and 1994 due to the construction or reconstruction of two utility lines and associated facilities. A formal consultation between the Rural Electric Authority and the Service has been completed for each of these actions. The Arizona Electric Power Cooperative was the project proponent.

- In late 1993, at least nine plants were lost and 43.38 acres of habitat were cleared for part of the La Canada Norte II housing development north of Green Valley. No Section 7 consultation was performed because this was a private action requiring no Federal permits or funding.

- An unidentified private development project north of Green Valley resulted in the loss of about 80 acres of habitat and more than 22 individuals of Pima pineapple cactus in 1993. No Section 7 consultation was performed because this was a private action requiring no Federal permits or funding.

- At least 2 plants and 60 - 70 acres of habitat were lost when the University of Arizona cleared land in the southern Avra Valley for a research project. No consultation was performed.

- In 1991, a prescribed burn on the Anvil Ranch in the Altar Valley, southwest of Tucson, have resulted at least 24 plants with some adverse effects. Effects to the habitat are unknown.

- A prescribed burn for spring 1994 is planned for approximately 1,690 acres on the Anvil Ranch, located within the Altar Valley, north of the Refuge. This fire may affect more than 185 individual Pima pineapple cactus. Incorporated into the project design is a long-term monitoring program to document changes in the plant community and studying the fire ecology of Pima pineapple cactus.

In addition to the projects mentioned above, the AESO is aware that an unknown number of private actions with adverse effects to Pima pineapple cactus have occurred since the species was listed. There is no estimate of the number of plants and amount of habitat that has been lost to these actions.

Environmental Baseline

Areas of the Altar Valley which are now part of the Refuge are considered to have once been representative of the Sonoran Savanna Grassland, a biotic community which now only exists as small, relictual stands in Mexico. The Sonora Savanna Grassland was a subtropical fire-climax grassland which occurred in valleys with level plains and gentle rolling hills on deep, fine textured soils. The principle grass species were summer-active root perennials such as Rothrock grama (Bouteloua rothrockii) and various species of three-awns (Aristida sp.). Other dominant plant species which were present were also of subtropic origins. Herbaceous shrubs and forbs were important components of this grassland community. Species characteristic of warm-temperate origins such as curly-mesquite (Hilaria belangeri) and side-oats grama (B. curtipendula) were likely restricted to sites along drainages and north-facing slopes. Most of the scrub species characteristic of the semidesert grassland such as burroweed and snakeweed were not typical components of the Sonoran Savanna Grassland Community, but probably occurred in the general vicinity. Trees and large shrubs were represented within this community, but varied in density. Larger cacti were present but not prevalent (Brown 1982).

Precipitation patterns in areas which were once primarily Sonoran Savanna Grassland are bimodal, winter-summer, but the greater percentage of precipitation falls during the summer months of July through September. Freezing temperatures occur but are not of long duration. With the summer rains comes a rapid growth of grasses and forbs. The amount of herbaceous growth is determined by the amount of summer rains (Brown 1982).

Livestock grazing has occurred in the Altar Valley for well over 100 years. Livestock grazing on what is now the Refuge occurred until 1985, the year the Refuge was established. Various grazing regimes were employed in the past and many management techniques were used to try to improve forage production for livestock. Prior to the establishment of the Refuge, large areas were burned, chained, disced, ripped, and seeded with exotic species of grasses. Impoundments, roads, and other facilities to support grazing were built.

The ecosystem in which the masked bobwhite quail historically occurred is now greatly modified. The historical prevalence of livestock grazing and associated impacts of humans on the landscape (including fire suppression, erosion, and introduction of exotic species) has transformed areas of the Altar Valley from a biotic community which may have at least approached the Sonoran Savanna Grassland into an inter-mix of desertscrub, semidesert grassland and mesquite/Lehmann's lovegrass grassland communities (Brown 1982). Velvet mesquite provides the primary tree component, though other species such as paloverde (Cercidium sp.) and hackberry are also found. Much of the Refuge is now dominated by mesquite which has encroached upon the grassland, and the non-native Lehmann's lovegrass. Large areas are nearly monotypic stands of Lehmann's lovegrass, while other patches are dominated by native perennial grasses. Past fires, including prescribed, wild, and human caused, have locally reduced mesquite densities, and/or have altered the form of mesquite.

Vegetation monitoring transects were established across the Refuge during the first few years after the creation of the Refuge. These transects are monitoring the long-term changes in the plant community following removal of livestock.

The natural fire frequency in southern Arizona grasslands is difficult to determine because methods such as tree-ring analysis typically used to estimate fire return frequencies are not useful. The information that is available indicates that before 1900, fires occurred at fairly regular intervals in southern Arizona forests. After 1900, there was a marked reduction in fires because 1) active suppression of fires had begun, 2) fine fuels had been removed by livestock or other practices such as haying, and 3) fires set by indigenous people had dwindled (Baisan 1990, Swetnam et al. 1989, Swetnam undated).

The introduction of the exotic Lehmann's lovegrass into southern Arizona in 1930 significantly altered the structure and composition of native grasslands. Lehmann's lovegrass is continuing to expand locally and regionally because it is relatively successful in disturbed areas. In many areas, nearly monotypic stands of Lehmann's lovegrass have replaced diverse native grasslands. Lehmann's lovegrass and other African lovegrasses have transformed the coarse-grained, patchy native grassland habitat into a finer-grained, less patchy habitat. Species richness and structural diversity of grasslands have declined in those areas. Lehmann's lovegrass mechanism of dispersal includes the abundant "rain" of seeds around the perimeter of lovegrass stands, intentional seeding by humans, and unintentional transport of seeds by vehicles. On the Appleton-Whittell Wildlife Sanctuary, total native herb canopy, herb species richness, shrub density, and shrub canopy were significantly reduced on plots dominated by the alien lovegrasses (Bock et al. 1986). McLaughlin (in litt. 1992) suspects that Lehmann's lovegrass is also expanding on the Refuge. However, Refuge personnel (W. Shifflett, Buenos Aires National Wildlife Refuge, pers. comm. 1994) have observed local decreases in Lehmann's lovegrass in favor of native grasses under certain fire regimes. Detailed analysis of Refuge vegetation transect data is not yet available.

The fine-grained, continuous fuels of a Lehmann's lovegrass stand burn with relative uniform intensity and thoroughness compared with the discontinuous fuels of some native grasslands. Within a single fire event in a native grassland, some patches may burn at high temperatures, while others experience light burning or do not burn at all. The difference in fire behavior between a native grassland and a Lehmann's lovegrass monoculture may be critical if Pima pineapple cactus exploits open habitat patches as a strategy to ensure long-term population viability. Open patches are far less frequent and much smaller in a Lehmann's lovegrass stand compared with a native grassland. Pima pineapple cactus in a Lehmann's lovegrass stand very likely has a higher risk of being burned and experiencing a higher temperature in a burn than a cactus in a native grassland fire.

Lehmann's lovegrass employs two successful strategies to compete with native species after a fire. Lehmann's lovegrass plants can be killed by hot fires, but those that are not killed can root from the nodes of decumbent tillers (Ruyle et al. 1988), thus maintaining and spreading the stand. Secondly, Lehmann's lovegrass produces large amounts of seed that are successful at germinating after a burn. Ruyle et al. (1988) found that germination of lovegrass seed averaged 40 percent higher in burned plots than in unburned plots. Cable (1971 and 1965) reported that Lehmann's lovegrass seedlings germinating after a fire converted a native black grama (Bouteloua eriopoda) stand to a Lehmann's lovegrass stand.

The combination of fire tolerance and abundant, well-adapted seed may favor the persistence or increase of Lehmann's lovegrass in areas that have been burned. On the Santa Rita Experimental Range, Martin (1983) found that Lehmann's lovegrass increased ten-fold on an area that had been burned four years previous, compared with a three-fold increase in an area that had not been burned.

The use of fire to restore disrupted grasslands to a native grassland community is not without its risks. Where Lehmann's lovegrass forms monotypic stands, fire will probably replace the existing lovegrass stand with another. Habitat conversion from a Lehmann's lovegrass stand to a native grassland should not be expected (Robinett pers. comm. 1994, Martin 1983, D. Thwaits, Coronado National Forest, Nogales Ranger District, pers. comm. 1994, Robinett 1992). Short-term benefits to wildlife may result because there is a short-term influx of annuals such as annual panic grass (Panicum sp.), spiderling (Boerhaavia sp.), and Tidestromia. The long-term effects are uncertain, but expansion of the existing stand and loss of additional native grassland is likely. However, the conditions under which the fire occurred (extent, intensity, timing, etc.) may effect the resulting response of the grassland community and the non-native Lehmann's lovegrass (Shifflett pers. comm. 1994). More research is needed into the fire ecology of non-native dominated grassland communities. The short- and long-term effects to Pima pineapple cactus are unknown.

The following hypothesis is proposed for testing as part of fire ecology studies on grassland communities with Lehmann's lovegrass. In some grassland areas, native species are dominant but Lehmann's lovegrass or other African lovegrasses exist at low frequency throughout the stand, either as discrete patches or as single individuals. When these types of stands burn, the risk of native species losing dominance to Lehmann's lovegrass is moderate to high (Robinett pers. comm. 1994). If burned, the patches of Lehmann's lovegrass are likely to increase in size. Therefore, the risk of burning these grasslands is moderate. The greatest risk to native species is posed by burning stands with scattered single individuals of Lehmann's lovegrass because fire apparently provides a competitive advantage to Lehmann's lovegrass over native species.

If a grassland does not contain exotic lovegrass species, then fire may pose little risk to native species dominance and will contribute towards maintaining community structure and diversity.

A prescribed burning program was initiated on the Refuge in 1988. Since that time, 31,896 acres in 40 burn units have been burned by prescription. Some of these fires occurred in winter months, when low intensity fires were used to thin existing grass stands in irregular patterns. Shifflett (pers. comm. 1994) reports that spring fires tended to be stand replacement fires and usually burned more thoroughly.

The probability of wildfires occurring on the Refuge is relatively high. On the Refuge, 2 - 11 wildfires per year occurred during the interval between 1988 - 1993, burning a total of approximately 24,000 acres. A large portion of these fires were small (less than 15 acres) in size. Of the 49 fires reported during this interval, 34 (69 percent) were less than 100 acres, nine (18 percent) were between 101 - 640 acres, five (10 percent) were larger than 640 acres, and one was of unknown size. One large wildfire covered 10,390 acres in 1986. The cause of these fires is unknown.

Effects of the Proposed Action

The effects of a prescribed burn on a plant community or plant populations are not always predictable. There are many variables to consider, including fire temperature and speed, return frequency, fuel loads, and the species composition, age, and structure of the pre-burn plant community. Complicating any prediction of community response is whether or not non-native species are present in the community and how they respond to fire.

The proposed action is a one year prescribed burning plan of fairly limited extent. Any direct negative effects to masked bobwhite quail or Pima pineapple cactus from this single action will likely involve few individuals and limited habitat area. However, the long-term ramifications of continued, large scale habitat manipulation through prescribed fire, for both the masked bobwhite quail and Pima pineapple cactus, is uncertain. The original Sonora Savanna Grassland community which formerly occurred in the Altar Valley is now gone. The altered biotic community now present is characterized by the local dominance of exotic grasses, continued expansion of mesquite into historic grassland habitats, increasing levels of shrubs and subshrubs, decreasing diversity and abundance of forbs, and increasing fuel loads which will ultimately contribute to conditions which may lead to high intensity wildfires. Fire no longer exists in its natural context within the Altar Valley. Returning fire to this highly altered ecosystem, as well as continuing its exclusion, has many risks. Without the information needed to support informed management decisions, the Refuge could further damage the very ecosystem it seeks to restore.

Continuing a year-by-year prescribed burn program without aggressively working towards an understanding of the fire ecology of grassland communities and Pima pineapple cactus as affected by Lehmann's lovegrass may threaten the continued existence and recovery of Pima pineapple cactus on the Refuge. It is the long-term restoration and maintenance of a natural functioning ecosystem, which includes fire, that is critical to the recovery of both the masked bobwhite quail and Pima pineapple cactus.

Masked Bobwhite Quail

Prescribed burns target bottomland/wash bottom habitats, which are generally the foraging areas preferred by masked bobwhite quail. The spring burns are expected to increase grass and forb diversity and top-kill mesquite trees (Shifflett pers comm. 1994). The goal is to produce a more diverse food supply including forb and insect species, open movement corridors, and enhance escape cover for masked bobwhites. Spring burns are also designed to reduce the density of subshrubs, reduce fuels on the ground, and generally to bring about a flush of new vegetation growth within the grassland. Observations by Refuge personnel of previously burned areas on the Refuge indicate that achievement of these effects is probable (Shifflett pers. comm. 1994), at least in the short-term.

Masked bobwhite quail currently use portions of the areas identified for prescribed burning. Adult birds that might be in the vicinity at the time of the burns are expected to be able to escape the slow-moving fire front. However, it is possible that adult quail may be killed by the fires. If nesting attempts are made prior to the onset of the summer rains, any eggs or chicks would probably be lost in the fire. However, loss of nests is not considered likely, because the proposed prescribed burns will be completed before the onset of the summer rains which is the primary trigger for reproduction in the masked bobwhite quail.

Masked bobwhite quail in and adjacent to burn areas may be initially disturbed by the greater human presence as result of ignition and fire control. Birds displaced during the fires may move to non-burned areas which are maintained within the normal movement distances of masked bobwhite quail.

Some direct adverse effects to masked bobwhite quail may occur as a result of the proposed prescribed burning. However, the overall effects of the project are expected to result in short-term improvement of masked bobwhite quail foraging habitat, which will facilitate the successful release of foster-reared broods. The long-term effects of these burns are unknown.

Pima Pineapple Cactus

Approximately 62 Pima pineapple cactus plants are currently known to occur on the Refuge. Of these, three are within the burn units identified for 1994. However, limited surveys for Pima pineapple cactus have been completed within these burn units. All known plants within the burn units will be individually protected from the fire. It is expected that undiscovered cacti are present within the burn units. Some of the plants which are suspected to occur in these burn units may die due to direct damage by fire or other indirect causes, while others may only be damaged. Some plants may escape the direct effects of the fire.

Other adverse effects of the proposed action could include temporarily increasing the visibility of the Pima pineapple cactus plants. This increased visibility could expose them to illegal collection, temporarily reduce associated plant cover on sites which may function to protect and nurse seedling cactus, and temporarily increase soil erosion, which may impact seedling plants. Fires may also accelerate the spread of Lehmann's lovegrass into the open habitat patches used by Pima pineapple cactus. Fires may actually perpetuate and even accelerate the expansion of monotypic stands of Lehmann's lovegrass.

However, potential adverse effects to Pima pineapple cactus may result if a prescribed fire program is not conducted. These effects include the accumulation of fuel loads that could increase the threat of high intensity fires. The long-term effects of fire within a Lehmann's lovegrass dominated community is uncertain, though published data indicates the perpetuation of a Lehmann's lovegrass dominated community.

The proposed prescribed burn on the Refuge may affect Pima pineapple cactus that occur within Lehmann's lovegrass stands and others that occur within less dense and less uniform fuel levels. Information collected before and after the burn may help determining the relative risks to Pima pineapple cactus of burning under conditions of different fuel levels and distribution of fuels as affected by the surrounding vegetation.

Concerns regarding the potential effects to Pima pineapple cactus from annual Refuge prescribed burning programs has been expressed by the AESO as part of each consultation for the last several years. The Refuge has incorporated surveys, protection of individuals, and cacti monitoring efforts into their annual burn program to address these concerns. As these efforts continue, it will contribute to our understanding of the Pima pineapple cactus and its fire ecology.

Cumulative Effects

Cumulative effects are those effects of future non-Federal (state, local government or private) activities on endangered or threatened species or critical habitat that are reasonably certain to occur in the foreseeable future. Future Federal actions are subject to the consultation requirements established in Section 7 of the Act, and therefore are not considered cumulative to the proposed action.

Within the range of Pima pineapple cactus, there are two blocks of land that are large enough to support a population of the species and that are unlikely to undergo residential or commercial development in the near future. The Refuge is the largest contiguous block of Federally managed land in the range of Pima pineapple cactus and contains the vast majority of Pima pineapple cactus individuals known to occur on Federal land. The Santa Rita Experimental Range, on the west slopes of the Santa Rita Mountains, is State land being managed by the Arizona State Land Department and the University of Arizona. An active prescribed burn program, livestock grazing, recreation, and research are the primary activities occurring there. Other State and private land within the range of the species is likely to be lost or fragmented due to commercial and residential development.

INCIDENTAL TAKE

Section 9 of the Act, as amended, prohibits any taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect or attempt to engage in such conduct) of listed species without a special exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Under the terms of 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered taking with in the bounds of the Act provided that such taking is in compliance with the incidental take statement. The measures describe below are non-discretionary and must be undertaken by the agency or made a binding condition of any grant or permit issued to an applicant, as appropriate.

The AESO anticipates, in agreement with the Refuge burn plan, that authorization and implementation of the 1994 Refuge prescribed burn program may result in direct mortality of up to ten masked bobwhite quail. The following reasonable and prudent measures and terms and conditions are necessary and appropriate to minimized the take of masked bobwhite quail:

Reasonable and Prudent Measures

1) Conduct the project in a manner which would minimize direct take of masked bobwhite.

2) Maintain complete and accurate records of actions which may result in take of masked bobwhite quail and their habitat.

3) Implement monitoring of the effects of the project on masked bobwhite quail and their habitat so that future actions can be modified to minimize take and maximize habitat improvement.

Terms and Conditions for Implementation

In order to be exempt from the prohibitions of section 9 of the Act, the following terms and conditions, which implement the reasonable and prudent measures described above, must be complied with.

1) Only persons trained in the prescription and control of fire shall conduct burning activities.

2) Areas proposed for burning shall be surveyed before burning to check for nesting or other signs of breeding activities of masked bobwhite quail. Prescribed fires will not be conducted in burn units where masked bobwhite quail have initiated any nesting activities.

3) Post-burn surveys will be conducted within and adjacent to the burn unit to search for any masked bobwhite quail that may have been killed by the prescribed burn.

4) A written record of the project, including maps of the project as planned and implemented, and appropriate photo documentation shall be maintained.

If, during the course of action, the amount or extent of the incidental take limit is reached, the Refuge must reinitiate consultation with the AESO immediately to avoid violation of section 9. Operations must be stopped in the interim period between the initiation and completion of the new consultation if it is determined that the impact of the additional taking will cause an irreversible and adverse impact on the species, as required by 50 CFR 401.14(i).

The incidental take statement provided in this opinion satisfies the requirements of the Act, as amended. This statement does not constitute and authorization for take of listed migratory birds under the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act or any other Federal statute.

Conservation Recommendations

Sections 2(c) and 7(a)(1) of the Act direct Federal agencies to use their authorities to further the purposes of the Act by conducting conservation programs for the benefit of endangered and threatened species. The term "conservation recommendations" has been defined as Service suggestions regarding discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information. The recommendations provided here relate only to the proposed action and do not necessarily represent complete fulfillment of the agency's Section 7(a)(1) responsibility for the species.

Many of the following conservation recommendations were included as part of the proposed action and are repeated and expanded upon here to emphasize their importance. The AESO recommends the following actions:

1. All known Pima pineapple cactus within the prescribed burn units should be protected from direct consumption by fire. Any of several strategies may be implemented to protect cacti: deferral of Pima pineapple cactus habitats from fire; protective screening, covers, or other devices used as fire shields; backfires; removal of surrounding vegetation by mowing or "weed whacking" to prevent fire or lessen the intensity of fire if it is expected to pass over the plant; or other methods determined to be appropriate for the site by Refuge personnel. Soils immediately surrounding the cacti should not be disturbed as part of these activities. Refuge personnel should determine the most appropriate method to be employed at any site.

2. Surveys for Pima pineapple cactus should be conducted prior to the ignition of fires. Surveys should be stratified if potential habitat can be identified. Surveys should be thorough in areas where there is a greater expectation of locating Pima pineapple cactus, such as in the vicinity of known plants and along ridge tops. Surveys for cacti could be incorporated, in part, into surveys for masked bobwhite quail and pre-burn brood release habitat evaluations.

3. Surveys for Pima pineapple cactus should be conducted following the burn. After the fire, it will be easier to locate cacti that were not discovered in the burn area before the fire. Comparing the results of pre-fire and post-fire survey efforts should provide an assessment of the thoroughness of pre-fire surveys and should refine the identification of potential Pima pineapple cactus habitat. Post-fire surveys for cacti could be, in part, incorporated into "mop up" activities, post-burn fire management evaluations, and searches for burned masked bobwhite quail carcasses.

4. Refuge personnel should continue tracking each individual Pima pineapple cactus within the proposed burn units. A data form, based on data sheets developed by the Refuge, has been modified by the AESO for use in several studies of Pima pineapple cactus. Please consider using this new data sheet to provide consistency among monitoring programs on and off the Refuge. A copy of the data form is attached. All known plants within the burn units should be evaluated both before and after

the fire. Any cacti found during the post-fire surveys should be documented using photographs (wherever possible) and data sheets. To determine direct and indirect mortality due to fire and any effects on reproduction, all cacti within the burn unit should be evaluated immediately after the fire, the summer following the fire, the next spring, the next flowering period (July), and during the flowering periods for the following two years.

5. A five-year fire management program should be developed by the Refuge to determine the long-term ecological effects of prescribed burning on the Refuge. This plan can address the sequential application of fire across the Refuge to provide for masked bobwhite quail brood release sites. A monitoring protocol should be developed to evaluate the ecological effects of various fire parameters, such as intensity, timing, and frequency, and to document the effects of fire in regards to the species composition and stand characteristics of the grassland and the presence of the exotic Lehmann's lovegrass. A complete analysis of the currently available data should be used to prepare the five-year plan. As new information becomes available, it should be incorporated into Refuge management decisions. If data indicate the native grass species are being replaced by Lehmann's lovegrass, management actions should be amended and the use of prescribed fire re-evaluated. The Refuge budget should reflect all costs for implementing this five-year burn program, including the costs for surveys and monitoring of masked bobwhite quail and Pima pineapple cactus, the costs for vegetation monitoring, and the costs for data analysis and report preparation.

6. Any actions requiring invasive ground disturbing actions, such as discing and plowing in Pima pineapple cactus habitat, will require thorough surveys for the cactus.

For the AESO to be kept informed of actions that either minimize or avoid adverse effects or benefit listed species or their habitats, the AESO is requesting notification of the implementation of any conservation recommendations. Depending on scheduling and work priorities, AESO personnel can be available to assist the Refuge in pre- and post-burn surveys for Pima pineapple cactus and collection of data.

Conclusion

This concludes formal consultation on the proposed prescribed burn. As required by 50 CFR §402.16, reinitiation of formal consultation is required if: 1) new information reveals effects of the agency action that may impact listed species or critical habitat in a manner or to an extent not considered in this opinion, 2) the agency action is subsequently modified in a manner that causes an effect to a listed species or critical habitat that was not considered in this opinion, or 3) a new species is listed or critical habitat designated that may be affected by the action.

In future communications on this project, please refer to consultation number 2-21-94-F-066. If we may be of further assistance, please contact Bruce Palmer, Sue Rutman, Tim Tibbitts, or Tom Gatz.

Sam F. Spiller

Attachment

cc: Chief, Fish and Wildlife Service, Arlington, Virginia (DES)
Regional Director, Fish and Wildlife Service, Albuquerque, New Mexico (AES and ARW)
Plant Program Manager, Arizona Department of Agriculture, Phoenix, Arizona
Director, Arizona Game and Fish Department, Phoenix, Arizona
Regional Supervisor, Arizona Game and Fish Department, Tucson, Arizona

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DATE: ________

FIELD DATA FORM: *Coryphantha scheeri* var. *robustispina*

PLANT NUMBER: __________ POST NUMBER: ______

LOCATION OF POST (distance & direction relative to plant): ____________________

LOCATION DESCRIPTION:

UTM: Latitude N: ______ Longitude E: ______
Township: _____ Range: _____ Section: _____ Subsection: _____
USGS Topographic quadrangle name: ____________________

ELEVATION: ______

Land Form	Drn chn	Valfil	lowslp	upslp	plat	rckter	cind
	fldpln	sdslp	mdslp	ridge	flvslp	cliff	talus
Aspect	N E	S W	NE NW	SE SW	Level		
Lithol	Alv	Ss	Sh	Ls	Met	IgIn	IgEx

DISCOVERY DATE: ___________ DISCOVERED BY: _________________

LAND OWNERSHIP: ________________________

PHOTO NUMBER: __________ PHOTO ORIENTATION: ______

DESCRIPTION OF PLANT COMMUNITY:
Plant Association: ____________________________________

% Cover: ____ Tree: ______ Shrub: ________ Grass & forbs: _______
Litter: ________

Distance from COSCRO to nearest woody plant (identify plant): ______________
____

Other notes: ____
____

(over)

DATE: ________

MANAGEMENT HISTORY (give dates; NA if not applicable; UK if unknown):

Livestock grazing: ______________________________

Wildfires: ______________________________

Prescribed burns: ______________________________

Mechanical treatments (chaining, imprinting, etc.): ______________________________

Other: ______________________________

CONDITION CLASSES:

AOK = Looks healthy

Fire Damage Classes:

N = No visible burn damage (stem is green, spines unaffected).
L = Light burn damage. No spines burned, less than 40% of stem shows cutical yellowing or other form of damage.
M = Moderate burn damage. More than about 40% of stem shows cuticle yellowing or other form of damage, some spines scorched or burned.
S = Severe burn damage. Less than 90% of stem is blackened.
VS = Very severe burn damage. 90% or more of stem is blackened.

Herbivory:

H = Herbivory by animals other than insects.
IH = Insect herbivory.

Other Notes:

TR = Plant damaged by trampling.
M = Meristem damage.
FB = Fuels immediately adjacent to plant burned.
DISC = a rotting discoloration.
DISC2 = a rotting discoloration that covers less than 50% of the stem.

Return to:

Sue Rutman
U.S. Fish and Wildlife Service
3616 West Thomas Road, Suite 6
Phoenix, AZ 85019

DATE: ________

DATA FORM: Coryphantha scheeri var. robustispina

Plant Number	Measured Variables	Mother Plant	Pup (see drawing, reverse of page) A	B	C	D	E	F	G
	Height (cm) Diameter (cm) Number of flowers/fruit Condition* Fire damage Other								
Event?									
	Height (cm) Diameter (cm) Number of flowers/fruit Condition* Fire damage Other								
Event?									
	Height (cm) Diameter (cm) Number of flowers/fruit Condition* Fire damage Other								
Event?									
	Height (cm) Diameter (cm) Number of flowers/fruit Condition* Fire damage Other								
Event?									

* See definitions, previous page