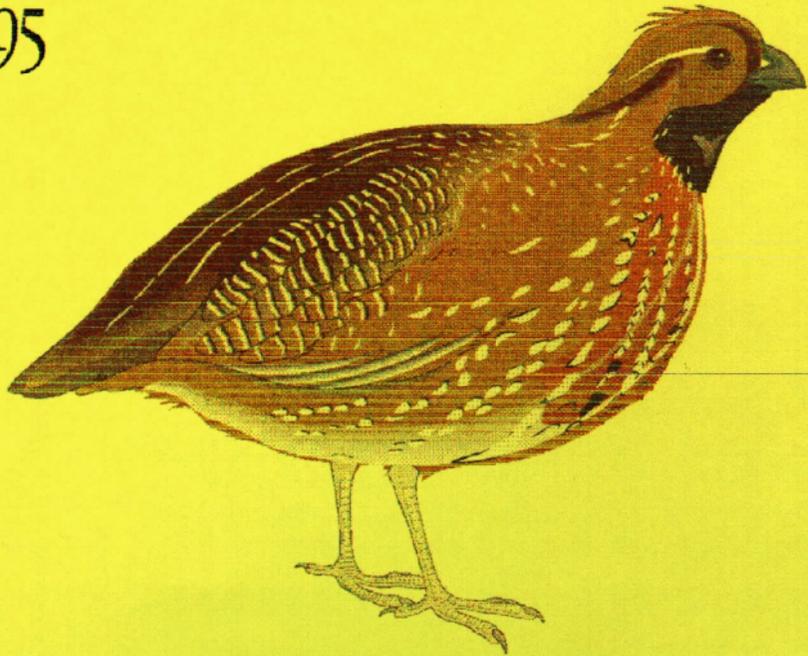


Masked Bobwhite Recovery Plan

April 1995



Buenos Aires National Wildlife Refuge
U.S. Fish & Wildlife Service
Region 2

MASKED BOBWHITE RECOVERY PLAN

Second Revision 1995

First Revision Approved: March 16, 1984

Original Approved: 1978

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For: Region 2

U.S. Fish and Wildlife Service

Albuquerque, New Mexico

Approved: _____

Acting Regional Director, U.S. Fish and Wildlife Service

Date: _____

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Recovery plans delineate reasonable actions that are recommended for the recovery and/or protection of listed species. Plans are published by the U.S. Fish and Wildlife Service, sometimes prepared with the assistance of recovery teams, contractors, State Agencies and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views nor the official positions or approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. They represent the official position of the U.S. Fish and Wildlife Service only after they have been signed by the Regional Director or Director as approved. Approved recovery plans are subject to modification as dictated by new findings, changes in species' status, and the completion of recovery tasks.

Estimates of cost and task duration as listed in Part III have some uncertainty depending on the nature of the task. Duration of research tasks are generally unknown. Because of their experimental nature, it is difficult to predict the time required to complete tasks and attain data required to verify statistical reliability. Costs of some management tasks are uncertain when they involve activities for which there exists no previous cost experience.

Literature Citations

Literature citations of this document should read as follows:

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Executive Summary

Species Status:

The masked bobwhite is federally-listed as an endangered species. Three populations, less than 1,000 individuals total, exist in Sonora, Mexico. One population of an estimated 300-500 individuals exists in the United States in south-central Arizona on the Buenos Aires National Wildlife Refuge (BANWR).

Habitat Requirements and Limiting Factors:

Masked bobwhite habitat is open savanna grassland within dry-tropic scrub. These birds are associated with weedy bottom lands, grassy and herb-strewn valleys, and forb-rich plains. This habitat type has declined as a result of overgrazing by livestock and periods of severe drought. Winter habitat within valley bottoms is crucial to the survival of Mexico's masked bobwhites. Life history information on the species is incomplete.

Recovery Objective:

Delisting.

Recovery Criteria:

To establish two viable populations in the United States, to cooperate with the Mexican Government in reintroducing two or more populations in Mexico, and to maintain and increase the existing populations in Mexico.

Actions Needed:

1. Maintain at least two captive populations at widely separated locations.
2. Continue release of propagated stock on BANWR until a viable self-sustaining population of 500 birds is established.
3. Implement habitat management on BANWR to maintain and increase the existing population.
4. Determine species biology, population dynamics, habitat needs, management and winter requirements in Mexico and U.S.
5. Assist in monitoring masked bobwhite populations in Mexico.
6. Establish and maintain at least two wild populations in Mexico.
7. Establish a second self-sustaining wild population in the U.S.

Estimated Cost of Recovery:

Costs (\$000's)			
Year	Priority 1	Priority 2	Priority 3
1994	3448	43	44
1995	1124.5	43	44
1996	1126	43	14
1997	790	43	14
1998	790	43	14
1999	790	43	14
2000	790	43	14
2001	790	43	14
2002	790	43	14
2003	790	43	14
Total	11,228.6	4.30	200

Date of Recovery:

If recovery criteria are met, down listing should be initiated in 2003. The date of full recovery cannot be predicted at this time.

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I. INTRODUCTION

First collected in 1884, the masked bobwhite (Colinus virginianus ridgway) became endangered soon after its discovery. With destruction of its native grassland habitat by range cattle, the masked bobwhite was essentially extirpated from Arizona by 1900. By 1937, demise of populations remaining in Mexico prompted efforts to reestablish the masked bobwhite in the United States. These restoration attempts proved unsuccessful, and by 1950 the subspecies was reported to be almost, if not completely, extinct in the wild. In 1964, the “rediscovery” of this bobwhite in Sonora revived interest and prompted additional attempts at restoration. These attempts were also unsuccessful and the masked bobwhite was among the fauna originally listed as endangered by the United States Government after the passage of the Endangered Species Conservation Act of 1960 (Public Law 91-135; 83 Stat. 275). The Endangered Species Conservation Act was superseded by the Endangered Species Act of 1973 (Public Law 93-205; 87 Stat. 884); however, the legal and biological status of the masked bobwhite remained “endangered.” Protection measures alone would not suffice. Recovery would require re-establishment of the bird in an altered ecosystem.

Experimental releases using foster parents and “call box” training, pursued intensively by U.S. Fish and Wildlife Service (FWS) researchers (Ellis et al. 1978) from 1975-1978, led to the re-establishment of a sizable population on a private ranch in Arizona near the Mexican border. In 1977, natural reproduction was confirmed at this location. At its peak in 1979, this population consisted of at least 74 calling males (Goodwin 1982). However, two dry summers and excessive grazing subsequently caused a drastic reduction in this population. cursory investigations in 1982 and 1983 confirmed only

a few birds remaining in the area (J. S. deVos and J. Levy, pers. comm. 1983). For the reintroduction and recovery to be successful, a sizable area was needed to manage specifically for the masked bobwhite.

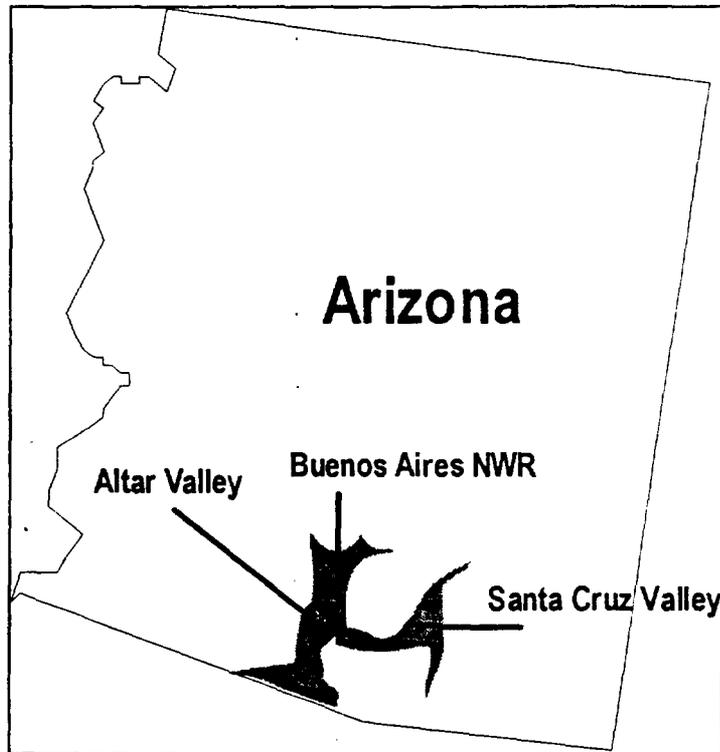


Figure 1.
Areas in Arizona considered most suitable for masked bobwhite management.

Since 1985, efforts to reestablish the masked bobwhite on the BANWR have included the release of chicks being foster-reared by wild, vasectomized Texas bobwhite (Colinus virginianus texanus) males, livestock removal, and habitat improvement. The results have been encouraging. In 1990, population estimates ranged from 300-500 masked bobwhites on the BANWR (Dobrott 1990). Refuge monitoring studies indicated a decline in the number of masked bobwhites in 1991, indicating that winter food reserves might be the cause of long distance movements observed in over-wintering coveys (Dobrott 1991).

In Mexico, the masked bobwhite population in the Benjamin Hill area continues to struggle for existence (Fig. 2). Recent surveys suggest dramatic decreases in both the southern (Rancho Grande and El Arpa) and northern population (Rancho El Carrizo) (Fig.3). In 1991, it was estimated that less than 500 masked bobwhites remained in these two populations (Dobrott 1991). The 1994 surveys do not indicate that either population has increased since then.

In 1991, a significant step was taken in Mexico to save the masked bobwhite from extinction. The Nature Conservancy, El Centro Ecologico de Sonora, the U.S. Fish and Wildlife Service, and private land owners in Sonora identified and protected approximately 50,000 acres of critical habitat within the areas occupied by masked bobwhite. Management strategies were also developed to enhance and expand masked bobwhite habitat thereby providing additional range for population expansion (Dobrott, 1991).

In 1992, a third satellite population was discovered adjacent to Rancho El Carrizo not far from the 1964 discovery site. Currently, the populations at Rancho Grande, El Arpa and Rancho El Carrizo are declining.

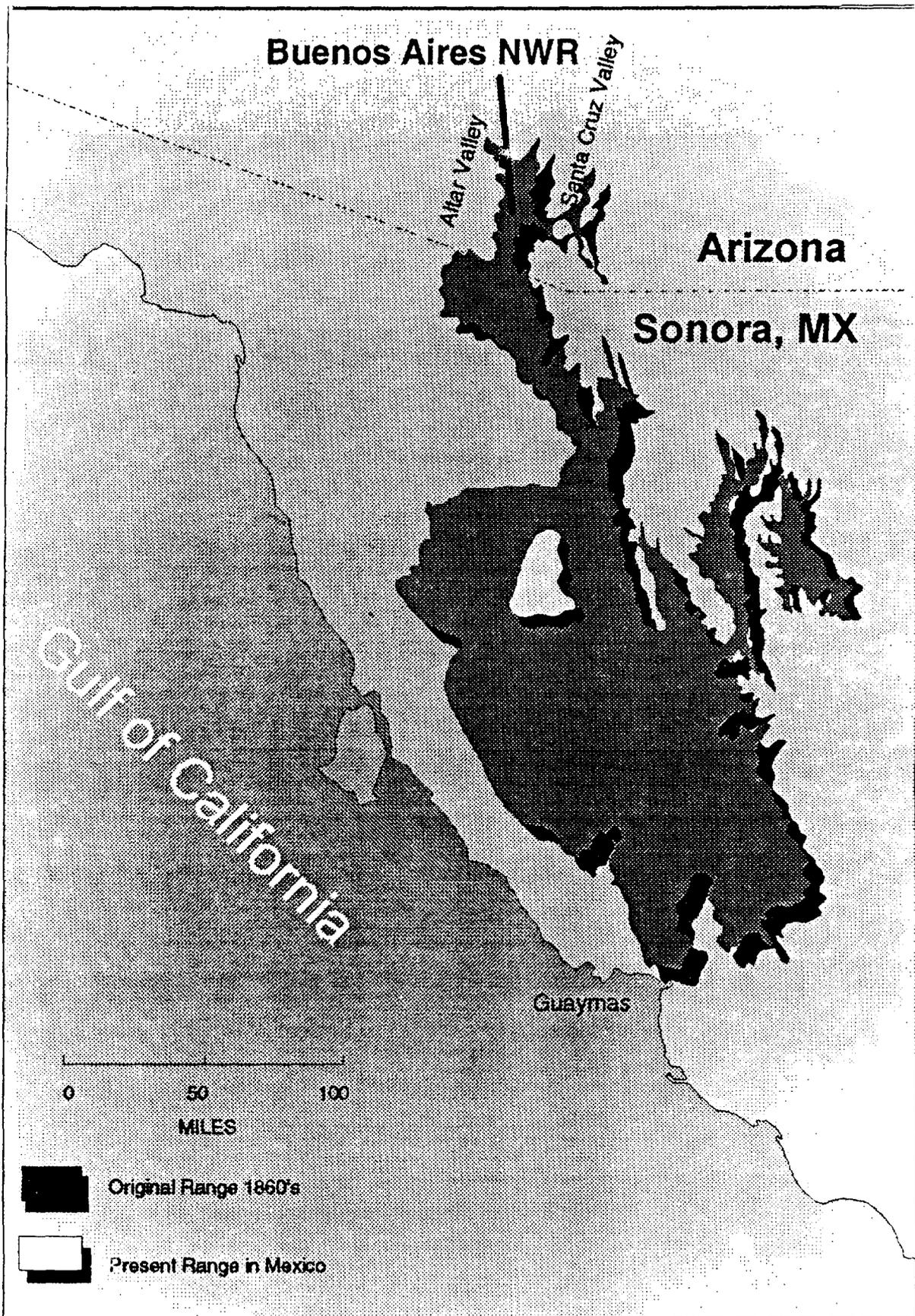


Figure 2. Historic range of the masked bobwhite

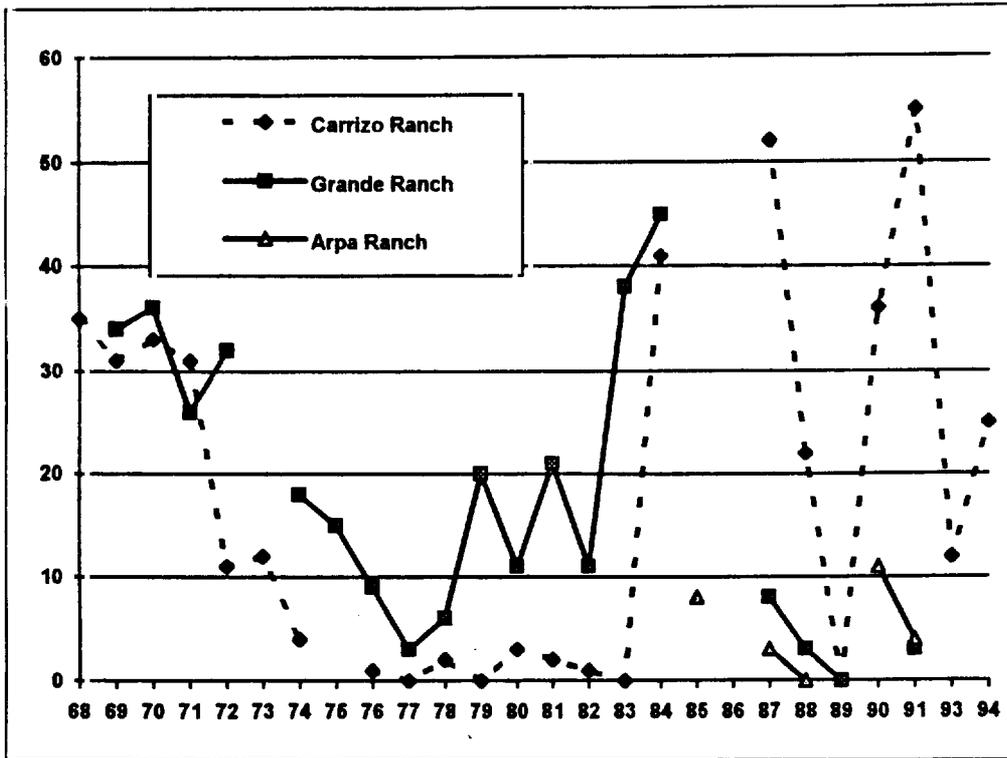


Figure 3. Number of calling males per route (peak rates)

A. Taxonomic Classification and Description

The discovery and early history of the masked bobwhite was summarized by Tomlinson (1972a).

Masked bobwhite were reported from southern Arizona and Sonora as early as 1864 (Coues 1903:6),

but none were collected until March, 1884 when Brown (1884) obtained two incomplete specimens.

Brown sent them to Ridgway, who identified them as Ortyx graysoni, a bobwhite found on the Pacific slope of west-central Mexico (Grinnell 1884). In August 1884, Stephens (1885) collected a male bobwhite 18 miles south of the border. The “Sasabe” bird eventually became the type specimen and

was named Colinus ridgwayi (Brewster 1885). Allen (1886a, 1886b, 1887) described the species thoroughly from 21 other specimens obtained in southern Arizona by Brown.

The scientific name of the masked bobwhite remained Colinus ridgwayi until the supplement to the American Ornithologist's Union checklist was published in 1944 when the name was then changed to Colinus virginianus ridgwayi. The trinomial, reducing the masked bobwhite to subspecific status, is presently the accepted nomenclature. From a series of 60 specimens from most portions of its presumed range (Fig. 2), Banks (1975) concluded that all populations were of a single, although highly variable, subspecies. There is no evidence that masked bobwhite integrated with other races in historical times, although its close resemblance to Ortyx graysoni suggests a link in the not-too-distant past with the black-headed bobwhites of the Pacific slope of southwestern Mexico (Johnsgard 1973).

Masked bobwhite males are characterized by a brick red and black head and throat. A varying amount of white is usually present on the head, particularly above the eye and occasionally on the throat (Banks 1975). Females closely resemble other bobwhite subspecies; they are essentially indistinguishable from the Texas bobwhite found in subtropical Texas and Tamaulipas, Mexico (Ridgway 1887:189). The masked bobwhite is smaller and darker than more northern forms of the species (Tomlinson 1975).

B. Distribution and Population Estimates

Historic accounts and collections indicate that this subtropical subspecies was always restricted to level plains and river valleys in Sonora and extreme south-central Arizona, between 150 and 1,200 m elevation (Brown 1885, 1904, Van Rossem 1945, Ligon 1952, Tomlinson 1972a, Fig. 2). As such, the primary residence of the masked bobwhite was the grassy savanna habitats (Ilanos) within Shreve's (1942, 1951) Plains of Sonora, subdivisions of the Sonoran Desert. These biotic communities have a

mean rainfall ranging from 250 to over 500 mm, of which more than 70 percent is received during July through September (Shreve 1951, Tomlinson 1972b).

The eastern and southern distribution is limited by the merging of Sonora savanna grassland and its summer-active grass-forb understories with the more structurally dense Sinaloan thornscrub where bobwhites are replaced by elegant quail (Lophortyx douglassi). Masked bobwhite occurrence south or east of the Rio Yaqui has yet to be documented. To the west and northwest, a decrease in summer precipitation excludes bobwhite from the desert scrub communities of the Central Gulf Coast, Lower Colorado River, and Arizona Upland subdivisions of the Sonora Desert. Northward and above 1,200 m in elevation, the subtropical scrub and grass understories of Sonora savanna grassland give way to sod forming perennial grasses, and shrubs, and leaf succulents characteristic of warm temperate desert grassland. At the northern limits of masked bobwhite range in the Altar and Santa Cruz valleys of Arizona, semidesert grassland replaces Sonoran savanna grassland and the masked bobwhite is supplanted by scaled quail (Callipepla squamata). Reports of masked bobwhites outside this range are unsubstantiated by specimens or other corroborating evidence.

From 1967 through 1970, Tomlinson (1972b) conducted an extensive search to determine the bird's distribution and status in Sonora. He visited published localities and collection sites, and interviewed hundreds of Mexican citizens. During the fall and winter, areas thought to harbor masked bobwhites were searched on foot with a dog. Cactus wren (Campylorhynchus brunneicapillus) and verdin (Parus spp.) nests (which are frequently lined with feathers of other birds) were searched for masked bobwhite feathers. The distinctive roosts of masked bobwhites were also sought. During the summer breeding season, Tomlinson listened for bobwhite calls, and used taped female calls to elicit male

responses. His investigations concentrated on eight general areas in Sonora (Fig. 1): (1) Benjamin Hill-Carbo, (2) Mazatan-Cobachi, (3) Rancho Agua Fria-Valle de Agua Caliente, (4) Tecoripa-Rancho La Cuesta, (5) La Misa and San Marcial, (6) Cumpas and Bacoachi, (7) Sasabe-Molinos, and (8) Siete Cerros (Tomlinson 1972b).

Masked bobwhites were located at two sites in the Benjamin Hill-Carbo area, Rancho Grande/El Arpa and Rancho El Carrizo, and a very limited region east of Mazatan (Tomlinson 1972b). Population trends in these areas justified concern. No masked bobwhites were found east of Mazatan in 1974, when Tomlinson, Dobrott and Ellis revisited the area. A few birds had been found there in 1968 in brushy habitat.

In the Benjamin Hill-Carbo area, Tomlinson established two call-count survey routes. In 1977, the trend in peak counts of calling males (Fig. 3) suggested the population at or near extinction at Rancho El Carrizo (Ellis and Serafin 1977). Field studies in this area also suggested this population was close to being lost.

Data collected (Goodwin 1981, Mills and Reichenbacher 1982) for the Rancho Grande/El Arpa route initially suggested an upturn, possibly associated with the extensive program of brush removal, windrowing, and planting of buffelgrass (*Cenchrus ciliaris*). However, this advantage was short-lived, because the buffelgrass formed extensive monocultures that outcompeted native vegetation. Such habitat is not suitable for the masked bobwhite.

From 1988 to 1992, population trends between the two areas appeared to reverse. While the Rancho Grande/El Arpa population declined to near extinction, the Rancho El Carrizo population increased on two core areas (Dobrott 1992). However, the Rancho El Carrizo population has declined since the 1992 surveys due to two extremely dry summers (1992 and 1993).

Despite recent surveys (Dobrott 1990), no other wild population of masked bobwhite is known to occur in Sonora. Considering the widespread deterioration of subtropical grasslands throughout Sonora, existence of any heretofore unrecorded population is unlikely. However, because large segments of the historic range have not been searched, and given the secretive habits of the bird as well as the difficulty of locating small, isolated populations, it is possible that additional populations persist in remote areas of Sonora. Indeed, two masked bobwhites were reported to have been live-trapped on a ranch approximately 400 km southwest of the Benjamin Hill-Carbo area during the winter of 1992-1993, and several birds were killed by hunters in the same area the previous winter (Engle-Wilson pers. comm. 1993).

C. Habitat

Masked bobwhite habitat in Sonora (Fig. 2) is relatively open, subtropic, summer-active savanna grassland within dry-tropic scrub. The scrub components are characteristic of Sinaloan thorn-scrub and Sonoran desert-scrub. At the extreme northern edge of the masked bobwhite range (Fig. 1), scrub components include a mixture of Sonoran species and dry-tropic species of warm temperate semidesert grassland (desert grassland). Abundant grass cover is seasonal in Sonora savanna grassland, as are a variety of summer-active forb and weed species.

The original nature and composition of these grasslands is conjecture. At present, frequently encountered grass and weed species include four subtropic root-perennial annual gramas. (Bouteloua rothrockii, B. aristidoides, B. parryi, B. filiformis), several species of three-awn (Aristida spp.), false grama (Cathestecum erectum), tanglehead grass (Heteropogon contortus), vine mesquite grass (Panicum obtusum), ragweed (Abrosia sp.), purslane (Portulaca sp.), spurges (Euphorbia spp.), pigweed (Amaranthus sp.), spiderling (Boerhaavia spp.), and others. Cane beardgrass (Andropogon barbinodes), Arizona cottontop (Trichacne californicum), sideoats grama (Bouteloua curtipendula and, to a lesser extent, black grama (Bouteloua eriopoda), are now restricted to the more favored and protected rockier sites. Blue grama (Bouteloua gracilis) and the “grassland” shrubs, burroweed (Isocoma tenuisecta) and snakeweed (Gutierrezia sarothrae), are conspicuously absent.

Trees and scrub components, although always present, vary in composition and density from site to site. In the southern and eastern portions of masked bobwhite range, and enormous variety of tropic-subtropic thorny scrubs and trees are present. At the northern limits, mesquite (Prosopis juliflora var. velutina) is ubiquitous and often the exclusive arboreal constituent. Frequently encountered and conspicuous species of trees and shrubs in and around masked bobwhite habitat near Benjamin Hill, Sonora, are: mesquite, ironwood (Olneya tesota), Palo Verde (Cercidium floridum, C. microphyllum, C. praecox), retama (Parkinsonia aculeata), guayacan (Guaiacum coulteri), acacias (Acacia angustissima and others), tomatillo (Lycium brevipes), Caesalpinia pumila, croton (croton sonoreae), desert hackberry (Celtis pallida), kidneywood (Eysenhardtia orthocarpa), Coursetia glandulosa, tree ocotillo (Fouquieria macdougalii), limberbush (Jatropha sp.), false mesquite (Calliandra eriophylla), Atamisquea emarginata, and partridge pea (Cassia leptadenia). Several species of cacti are also conspicuous, but not abundant. Freezing temperatures are infrequent, and almost never exceed 24

hours duration. July through September rainfall averages 250 mm or more (Hastings and Humphrey 1969).

Masked bobwhites are associated with grassy river bottoms, broad level valleys, and plains. In southern Arizona, Brown (1885) observed Gambel's quail (*Callipepla gambeli*) in rough, canyon-like country, scaled quail in wide grassy plains, and masked bobwhites on the mesas and in the plains, but not in the canyons. Stephens (1885) found several masked bobwhites near a camp in Altar Valley (Fig. 1), which he described as possessing "the best grass we saw on the route" (Tucson to Puerto Lobos, Sonora). He unsuccessfully attempted to collect a bobwhite in "this open prairie."

Recalling conditions in the Altar Valley between the time of his arrival in 1885 and the turn of the century, pioneer rancher Manuel King (Arrington 1942) stated that "sacaton (*Sporobolus wrightii*) and Johnson grass (*Sorghum halapense*) (the observation of this exotic grass at such an early date is an error) covered the entire Altar valley from the slopes of the Baboquivaris to the Cerro Colorado and Sierrita Mountains. Only an occasional tree was growing, and haystacks of native grasses, harvested by farmers and ranchers, were common everywhere in the fall and winter." He described masked bobwhites as then "numerous" (Arrington 1942). Both Brown (Allen 1886a) and Stephens (1885) reported that masked bobwhites used sacaton grass, a coarse bunch grass restricted to bottomlands, as escape cover.

Additionally, Brown and Stephens mentioned mesquite, then restricted to drainageways and bottomlands, as a common component of masked bobwhite habitat. Van Rossem (1945) stated that the masked bobwhite resided in grass plains, river valleys and foothills in the Lower Sonoran Zone.

Ligon (1952) said: "This quail is definitely a dweller of deep-grass-weed habitat, a type of cover incompatible with heavy use by livestock." Phillips et al. (1964) described masked bobwhite habitat as "tall grass-mesquite plains." Gallizioli et al. (1967) stated that "Early references and recent observations in Sonora indicate that dense stands of perennial grasses are an important component of masked bobwhite habitat."

Habitat preferences of reintroduced masked bobwhite were studied in detail from 1979 to 1981 on the Buenos Aires Ranch, now BANWR, in the southern Altar Valley, just north of Sasabe, Arizona (Goodwin 1982). Masked bobwhite almost exclusively used the bottomlands of the main and side drainages. Masked bobwhites exhibited a specific range of preferences for understory shrub cover and grass-forb density and diversity within this general habitat type; they were generally absent in areas with less than 8 percent shrub cover. Instead overstory shrub cover of 15-30 percent was preferred. Young mesquite (basal diameter <10 cm) with low, pendulous branches close to the ground appeared ideal. Large mesquite provided little cover at ground level. Goodwin believed the proper size and distribution of overstory cover was an important limiting component of masked bobwhite habitat on the Buenos Aires Ranch.

When the proper amount of overstory cover was present, grass and forb density, height, and diversity largely determined masked bobwhite presence. Monocultures of even such important food species as vine mesquite grass and Johnson grass were avoided. Goodwin (1982) stated that, "with few exceptions, bobwhite were not observed in areas with less than 10-12 species of grasses and forbs, and the areas supporting the best quail populations generally contained 18-20 plant species." He further concluded that bobwhite seemed to prefer areas with 500-1,000 kg/ha grass and 300-800 kg/ha forb

weight; however, the number of species present and ground cover provided was more important than sheer weight of plant material. Sites with less than 10 percent grass cover were avoided. Preferred habitat had 22-30 percent combined grass-forb cover. Finally, he observed that several coveys emigrated when the grass-forb understory was reduced (by grazing) to 400 kg/ha and 12-15 cm height.

Home range, habitat use, and movements of reintroduced masked bobwhites were studied during 1986-88 on BANWR (Simms 1989). Home ranges averaged 10.9 ha (5.2-14.6 ha), and core areas averaged 1.1 ha (0.2-2.7 ha). Visual obstruction from vegetation on core areas was significantly higher, from 0-1 dm for aerial and basal grass cover. Visual obstruction from 5-20 dm was significantly lower for bare ground, litter, half-shrub cover, and half shrub density on core areas than non-core areas. The majority of the masked bobwhites moved less than 1 km between their release location and the site of first trapping. However, some long distance movements occurred. After home ranges were established, masked bobwhite seldom left the boundaries.

D. Life History

Masked bobwhites usually remain in coveys until late June. Pair bonds are formed in the covey unit. Pairs gradually separate from the covey as the breeding season approaches, but loose coveys containing several pairs and single males are still common into late June and early July. Breeding normally begins when summer rains commence (in July). The onset of the breeding season is heralded by the well-known "bob-white" call of the male. Call-counts by Tomlinson (1972b) showed that males began calling between June 25 and July 15, and terminated calling between September 4 and 20 for the years 1968 through 1970. Calling frequency in Sonora typically reached a maximum between August 10 and 24, after which it declined rapidly.

Most nesting attempts occur on the ground and coincide with the period of peak calling activity.

Ground cover is essential to conceal the nest, and nesting may be delayed until sufficient grass or other herbaceous growth is available. Nesting success is related to the amount of ground cover. It also is correlated with the amount and distribution of summer precipitation and with male calling activity.

Hatching begins in late July, peaks during the period September 5-20, and ends by late October to early November (Tomlinson 1972b). The earliest broods were seen in late September, and most broods consisted at that time of very small chicks (Tomlinson 1972b). Breeding, nesting, and hatching cycles are timed to exploit the availability of plant food and cover and invertebrate prey produced in response to summer rains. Newly hatched broods consist of 5 to 15 young (average 11). The brood is the nucleus of the fall-winter covey. Unproductive adults and young separated from other broods may join a covey, but covey size rarely exceeds 20 birds (Tomlinson 1972b).

Many aspects of masked bobwhite life history have yet to be investigated. These include seasonal food habits and mortality factors. Masked bobwhites use a large variety of legume and weed seeds during fall, winter, and early spring (Cottam and Knappen 1939). Vegetation and insects are undoubtedly important dietary items during summer and early fall.

Annual mortality rates for the masked bobwhite, though little studied, are believed similar to the rates (about 70 percent) for other bobwhite races (Rosene 1969). Mortality of 18 adult birds in the early Buenos Aires Ranch population was attributed to avian (14) and mammalian (4) predators (Goodwin 1982). Later studies of reintroduced bobwhites on the BANWR documented 51 mortalities (42 masked bobwhites and 9 Texas bobwhites). Raptors killed 21 bobwhites and mammals killed 5. Four

birds were believed to have succumbed to hypothermia. Survival and nesting success are believed to depend heavily on availability of herbaceous cover. When cover is insufficient, birds are more vulnerable to predation, and forced to disperse. A covey in Arizona, maintained its numbers for three months in a well vegetated pasture (Goodwin 1982). The covey then moved as a consequence of overgrazing and the associated base loss of cover, losing six members to predation within the first few weeks after their move.

E. Reasons for Listing

In the late 1880's, cattle grazing caused the deterioration and destruction of much of southern Arizona's grasslands (Brown 1900, Hastings and Turner 1965, Hollon 1966, Wilson 1976).

Simultaneously, masked bobwhite began a rapid decline and were probably extirpated from Arizona by the turn of the century. The last specimens from Arizona were those taken for Brown at Calabasas, December 29, 1897 (Phillips et al. 1964). Brown (1904) lamented, "unfortunately there are none left to protect."

Competent observers familiar with masked bobwhites reported seeing birds through the 1930s however, and Ligon (1942) wrote: "reports of masked bobwhites having been observed in the Arivaca section and on the Baboquivari range west of Altar Valley persist to this day." These sightings were neither confirmed by other observers nor substantiated by specimens. Thus, for all practical purposes, masked bobwhites were extirpated from Arizona by the early 1900s (Tomlinson 1972b).

The arrival of Europeans and their livestock in Sonora predates colonization of Arizona. However, the settlement of Sonora was slow and areas away from river valleys remained uninhabited by Europeans into the late 1880s. Benson and Cahoon separately collected birds in and around Cumpas and

Bacoachi in 1886 and 1887 (Brewster 1887, Van Rossem 1945). With the elimination of nomadic Apache and Yaqui Indian populations (1850-1900), settlement of Sonora accelerated. Masked bobwhites have not been reported from these two areas since then. After the Mexican revolutionary period (1911-1927), establishment of “ranchos” in Sonora was again accelerated through the development of permanent water. By the late 1920s and early 1930s, some ornithologists were concerned that the masked bobwhite might be extinct (Bent 1932). However, Ligon (1952) reported that birds were “still fairly numerous locally as late as 1937 in central and southern Sonora, Mexico.”

When Ligon returned to Sonora in 1949 and 1950, the situation had changed. “Ranch men who had formerly known of the presence of the birds advised that they seemed to have vanished overnight.” (Ligon 1952). No observations of masked bobwhite were reported from Sonora between 1950 and 1964, when Steve Gallizioli, an Arizona Game and Fish Department biologist, and naturalists Jim and Seymour Levy relocated a population between Benjamin Hill-Carbo and Hermosillo (Gallizioli et al. 1967). Circumstantial evidence associating the demise of masked bobwhites with heavy livestock grazing is overwhelming. Brown (1904) said:

“The causes leading to extermination of the Arizona Masked Bobwhite (*Colinus ridgwayi*) are due to the overstocking of the country with cattle, supplemented by several rainless years... This combination practically stripped the country bare of vegetation.”

Hollon (1966) reports that there were approximately 5,000 cattle in Arizona in 1870; 135,757 in 1880; and by 1890, there were 927,880. Wilson (1976) reported an estimate of over 1,500,000 cattle on Arizona ranges, mostly in southern Arizona, at the beginning of 1891. Brown (1900) described the

result: “During the years 1892 and 1893 Arizona suffered an almost continuous drought, and cattle died by tens of thousands. From 50 to 90 percent of every herd lay dead on the ranges. The hot sun, dry winds, and famished brutes were fatal as fire to nearly all forms of vegetable life. Even the cactus, although girded by its millions of spines, was broken and eaten by cattle in their mad frenzy for food. This destruction of desert herbage drove out or killed off many forms of animal life hitherto common to the great plains and mesa lands of the Territory. Cattle climbed to the tops of the highest mountains and denuded them of every living thing within reach.”

The Chairman of the Livestock Sanitary Commission, C. Cameron, said that if the drought of 1891-1893 had continued 60 days longer, all the cattle in southern Arizona would have perished (Wilson 1976).

With the expansion of cattle ranching throughout Sonora after 1930, the masked bobwhite began to disappear there also. Ligon’s (1952) report of trips in 1937 and 1950, and Wright’s experiences between 1931 and 1950 indicate the once luxuriant grassy plains were denuded within that time span (Tomlinson 1972a).

In summary, the extirpation of masked bobwhite resulted from the destruction of the fragile subtropical grassland ecosystem upon which the bird depended. The level valley bottoms and accessible “Ilanos” are very susceptible to livestock concentrations and are easily overgrazed. The bobwhites disappeared with the reduction of the grasses. The continuing loss of cover is now more aggravated in Sonora than at any other time in recorded history. The once luxuriant grassland habitats within the plains and foothills of Sonora have now largely disappeared, and are increasingly invaded by thornscrub. Cattle

and other livestock remove the grasses and forbs, thus depriving the masked bobwhite of nesting habitat, cover, and food. The lack of understory prevents fire from destroying invading woody plants, and the bird's habitat is gradually replaced by scrub (Humphrey 1958). These habitats are then occupied by scaled quail or Gambel's quail or in the east and southeast, by elegant quail.

F. Conservation Measures

Past restoration efforts:

Several early (1937-1950) attempts were made to reintroduce masked bobwhite to Arizona, and to restore or bolster populations in Sonora (Table 1). J. Stokley Ligon initiated three expeditions to Sonora to obtain stock for reintroduction and propagation in 1937, 1949, and 1950 (Ligon 1942, Lawson 1951, Ligon 1952). In 1937, 132 bobwhites were captured, and another 25 were obtained in 1950. Restocking efforts following the 1937 trip resulted in the initial release of about 200 birds (including wild and propagated stock) in six areas of Arizona and southwestern New Mexico. Most of these releases were well outside the presumed historic range of the masked bobwhite (Fig 4). None of the releases resulted in a population becoming established. Areas within the bird's known range were not selected as release sites because Arrington and Ligon believed range conditions in historic habitat were totally unsuitable for the masked bobwhite (Arrington 1942). The latest collections and reports of masked bobwhites in Arizona (Ligon 1942, Phillips et al. 1964) were at the upper elevational limits of the bird's habitat, consequently Ligon (and others) may have concluded that the bird's historic range included the desert grassland.

Table 1. Summary of early (1937-1950) masked bobwhite releases

Release No.	Date	Locale	No. Birds	Treatment	Party	Results	Source
40.0	Before Mr 1940	21 km. S. of Animas, NM	20	Wild trapped Dec. 1937	J.S. Ligon	Failed	Campbell, 1968
41.1	5/16/41	Brophy Ranch Babocomari, Grant, Elgin, Cochies, Co., AZ. Sec. 7, T.21S., R. 19E (exact release site questionable)	24	Ligon game farm propagated	L. Lawson	Possible observation of chicks. Eventually failed.	Tomlinson, 1972, PWRC files, and Ligon, 1942
41.2	5/16/41	Wm. Riggs Ranch, Dos Cabezas, AZ. Seeptank, Sec. 25, T.17S., R.27E	24	Ligon game farm propagated	L. Lawson	"With a few chicks hatched." Failed	Tomlinson, 1972, PWRC files, and Ligon, 1942
41.3	5/17/41	Charles Beach Ranch, SE of Vail Pima Co., AZ. Sec. 22, T. 16S., R. 27E		Ligon game farm propagated	G. Beach	Birds persisted well until area flooded in late fall. Failed	Tomlinson, 1972, PWRC files, and Ligon, 1942
45.1	Pre-1945	Ca. Joseph City, Navajo Co., AZ	?	?	?	Failed	Map& field note in AGF files.
45.2	Pre-1945	Ca. Holbrook, Navajo Co., AZ	?	?	?	Failed	Map& field note in AGF files.
50.1	Early 1950's	Black Bill Canyon Ca. 40 km. S of Animas, NM	?	?	?	Failed	Campbell, 1968
50.2	12/50	Garden Canyon, Huachuca Mtns. AZ	15	Wild birds trapped from Sonora, held 3 days at site	?	Seen for 10 days. Failed.	Pratt, 1965 Anon, 1959, & Lawson, 1951

In 1963 and 1964, the Levy brothers and personnel at the Arizona Sonora Desert Museum in Tucson, began separate studies of the masked bobwhite using breeding stock obtained from Ligon (Walker 1964, Gallizioli et al. 1967). The latter study was terminated when vandals entered the breeding pens and destroyed the remaining propagated birds. The Levys, with assistance from the Arizona Game and Fish Department, tried to convince a Sonoran landowner to set aside a portion of his ranch as a bobwhite management area. After some initial encouragement, this attempt also failed. In 1966, the Levys donated four pairs of pen-reared masked bobwhite to the USFWS. These birds, and 57 wild birds captured near Benjamin Hill-Carbo, Sonora, in 1968 and 1970, became the original breeding stock at the USFWS's Patuxent Wildlife Research Center in Laurel, Maryland.

In 1969, searches were initiated by the USFWS with the cooperation of the Arizona Game and Fish Department for suitable reintroduction sites in Arizona. Tomlinson's life history studies had just begun and not enough was known about masked bobwhite habitat requirements to make definitive evaluations. Criteria used in selecting release areas were range condition, historic distribution, land status and availability, amount and composition of ground cover, recent land use practices, and altitude. Although little was known about masked bobwhite food habits, an effort was made to choose areas believed to contain an adequate quail food supply.

Four areas were eventually selected as release sites in 1970, all in the Altar Valley. No areas in Arizona were found to be comparable to presently occupied habitats in Sonora. Generally, most of the Arizona habitat is higher (730-1,300 m) than the Sonoran habitat (300-800 m). The terrain in Arizona is generally rockier and the subtropic vegetation is sparser than in

Sonora. In both Arizona and Sonora, much of the land has been abused by livestock. Although the areas selected were less than ideal, they represented the best available release sites.

In 1972 the USFWS leased 1,840 acres (745.2 ha) of the Las Delicias Ranch (Altar Valley) from the State Land Department. These pastures are within the known range of masked bobwhite, and were to provide nesting habitat free of livestock grazing. When releases of captive stock revealed that this habitat was not preferred, the lease was terminated. Later, 1,150 acres (465 ha) of habitat on the nearby Buenos Aires Ranch were leased from 1978-1981, primarily to provide for bobwhite habitat studies.

Masked bobwhites were released in Arizona on several occasions from 1970 through 1979 (Table 2). In 1970 the first pen-reared birds were shipped from Patuxent Wildlife Research Center to Tucson, Arizona, and released into the wild. These birds were fed, watered and held for 24 hours before being released. Many of the birds suffered deformities from excessive debeaking and confined rearing. After 1971, birds were held in Tucson for three months prior to release. However, until 1974, masked bobwhites were released with little conditioning to the wild and most of them disappeared within two months. Abnormally high mortality rates due to coyote (Canis latrans) predation were documented immediately after release (Ellis and Tomlinson 1974, Goodwin and Hungerford 1977).

Table 2. Summary of recent (1970-1982) masked bobwhite releases

No.	Date	Locale ¹	# Birds	Type ²	Treatment	Results
70.1	3/4/70	Santa Margarita Ranch	114	Adults reared 1969	All birds held 1 day, then given "gentle" release. Mar. & may release Ca. 20 per covey. Oct. releases in 3 lg. coveys.	8 raptor kills found; high rapid mortality most birds gone within 1 month.
70.2	3/11/70	Rancho Seco	46	Adults reared 1969		
70.3	5/7/70	Buenos Aires Ranch (Fresnal)	40	Imm. reared winter 1969-70		
70.4	5/7/70	Buenos Aires Ranch (NW Canoa)	33	Imm. reared winter 1969-70		
70.5	10/21/70	Buenos Aires Ranch (Lower Arivaca Wash)	59	Imm. reared summer 1970		
70.6	10/21/70 1970	Rancho Seco Total	59 351			
71.1	10/14/29/30 July Relevant	Rancho Seco Information Unavailable 1970 Total	159 252	Adults	297 Birds received 29 Mar. 1971 and held until July; hen scratch given with game bird chow; held in pen at site 1 day; released "gently"	Longer survival than 1970; population observed; 2 predator caused deaths found; birds dispersed slowly over a few days; a few survived 6 months minimum and at least 2 produced in semi-wild state.
--	?1972	Exp. Station at Jiutepec near Mexico, D.F.	59	Adults	Received 9 May; release method unknown	?
72.1	5/19/72	CIPES ³ Exp. Station N of Carbo, Sonora, Mexico	240	Adults	Received 9 May & immediately taken to release site.	?
72.2	4/7-10/72 6/20-21/72 7/18/72	Las Delicias Ranch	100 100 100	Adults Adults Adults	300 received Mar.; 300 received Apr.; Birds held 1-3 months; "gentle" release.	High mortality, drought and low survival.
72.3	4/5-6/72	Buenos Aires Ranch (N)	83	Adults	Birds held 1-3 Months; "gentle" release	Low survival rates

No.	Date	Locale	# Birds	Type	Treatment	Results
72.4	4/5-6/72 6/21/72 7/19/72	Rancho Seco 1972 Total (Arizona & Sonora)	98 50 32 811	Adults Adults Adults		
73.1	4/10- 12/73	Buenos Aires Ranch (NW Canoa)	147	Adults	Birds received Mar. & Apr.; held 1-3 mo. on wild bird diet before release; 6-16 hr. at release site before "gentle" release; mammalian predator control deemed beneficial.	Most gone within 2 mo. Ca. 20 males calling in Aug. at Las Delicias Ranch poor summer rains.
73.2	4/11- 12/73	Rancho Seco	52	Adults	Birds received Mar. & Apr.; held 1-3 mo. on wild bird diet before release; 6-16 hr. at release site before "gentle" release; mammalian predator control deemed beneficial.	Most gone within 2 mo. Ca. 20 males calling in Aug. at Las Delicias Ranch poor summer rains.
73.3	7/17- 20/73	Las Delicias Ranch 1973 Total	275 474	Adults		
74.1	5/1-2/74	Las Delicias Ranch (Feedlot)	30	Adults	Birds received Apr.; birds introduced to seed mixture; birds held at release site before "gentle" release; mammalian predator control deemed beneficial.	Rapid high mortality mammalian predation important, a few birds survived to Nov.
74.2	6/13/74 7/11/74	Las Delicias Ranch (Feedlot)	308	Adults		
74.3	10/30/74	Las Delicias Ranch (Holding pasture) 1974 Total	9 347	Adults	Call-box method.	
75	4-12/75	Las Delicias Ranch 1975 Total	Ca. 650 Ca. 650	Small chicks, juveniles & adults	Various adoption & conditioning methods. (Largely experimental)	Two release methods yield good wild birds: but generally poor survival and/or emigration resulted.

No.	Date	Locale	# Birds	Type	Treatment	Results
76.1	4-5/76	Las Delicias Ranch	Ca. 89	Adults	Call-box method	Wild like on final release several survived through the season. Many observations of coveys months after release. A population of Ca. 30 birds in breeding condition in Aug. 1977. First wild reared chicks observed on 4 Oct. 1977.
76.2	4/10/76	Buenos Aires Ranch (Puertocito Wash)	Ca. 54	Adults	Call-box method	
76.3	7-8/76	Las Delicias Ranch	Ca. 148	Chicks	Foster-parent releases	
76.4	8-10/76	Buenos Aires Ranch (Puertocito Wash)	Ca. 556	Chicks	Foster-parent releases	
76.5	11/6/76 12/17/76	Upper Santa Cruz Valley Upper Santa Cruz Valley	6 19	Chicks Chicks	Flight-pen conditioned Call-box method Birds held 1-3 Months; "gentle" release	Little follow-up. Presumed to have failed
		1976 Total	Ca. 872			
77.1	1-5/77	Upper Santa Cruz Valley	187	Adults	Call-box method	Little follow-up. Presumed to have failed
77.2	4/26/77	Lower Santa Cruz Valley (Canoa Ranch Hdqt.)	69	Adults	Flight-pen conditioning	
77.3	5/7/77	Upper Santa Cruz Valley	49	Adults	Flight-pen conditioning	
77.4	7/22/77	Lower Santa Cruz Valley (Arivaca junction)	75	Chicks	Foster-parent releases	
77.5	8-10/77	Buenos Aires Ranch (Mexican border to Pozo Nuevo Hdqt.)	780	Chicks	Foster-parent releases	Many observations of wild coveys. Many records of wild reproduction. Small population established through 1981 at 8 locations.
77.6	9-10/77	Buenos Aires Ranch (Puertocito Wash)	68	Juveniles	Flight-pen conditioning	
		1977 Total	1228			
78.1	8-9/78	Buenos Aires Ranch (Secundino Trap)	166	Juveniles 4-7 weeks old		Many observations of wild coveys in this area from these and/or previous releases.
		1978 Total	166			

No.	Date	Locale	# Birds	Type	Treatment	Results
79.1	7-9/79	Buenos Aires Ranch (Puertocito Wash)	535	Chicks	Foster-parent releases	Many observations of wild coveys in this area from these and/or previous releases.
		1979 Total	535			
80.1	7-8/80	CIPES ³ Exp. Sta. N. of Carbo, Sonora, Mexico	465	Chicks	Foster-parent releases	Four males calling July 81; long term survival prospects poor.
80.2	8/19/80	Rancho La Cuesta, Sonora, Mexico	276	Chicks	Foster-parent releases	Nine calling males identified in 1981, indicating some first-year survival.
		1980 Total	745			
81.1	7/8-29/81	CIPES ³ Exp. Sta. N. of Carbo, Sonora, Mexico	316	Chicks	Foster-parent releases	To be determined
81.2	8/18/81	Rancho La Cuesta, Sonora, Mexico	380	Chicks	Foster-parent releases	To be determined
81.3	10/8/81	Rancho La Cuesta, Sonora, Mexico	377	Immatures reared summer	Flight-pen method	To be determined
81.4	10/7/81	Green Valley, AZ	40	Immatures reared summer	Escaped holding pens	Survival unlikely
		1981 Total	1113	1981		
82.1	8/82	Rancho La Cuesta, Sonora, Mexico	132	Chicks	Foster-parent releases	To be determined
82.2	8/82	Rancho San Fermin, Sonora, Mexico	809	Chicks	Foster-parent releases	To be determined
		1982 Total	941			

¹ See map (Figure 1) for approximate locations.

² All birds were pen-reared stock from PWRC, Laurel, MD.

³ Centro Investigaciones Pecuarías Estado Sonora.

A screening program was initiated in 1974, and only those birds thought capable of surviving in the wild were released (Ellis and Serafin 1977). Two reintroduction techniques were developed which resulted in release-worthy stock (Ellis et al. 1978). One is a modification of the foster parent-adoption methods described by Hart (1933), Stoddard (1936), and Stanford (1952). The most promising foster parents are wild caught male Texas bobwhites sterilized by bilateral vasectomy (Ellis and Carpenter 1981). The second technique is a modification of the call-box or call-pen conditioning program originally proposed by Hardy and McConnell (1967).

These techniques were developed in 1974 and 1975, and tested with hundreds of birds from 1974 to 1977 (Table 2). With this shift toward pre-release training programs, captive-bred birds were better prepared for survival in the wild (Ellis et al. 1978). Many of the birds released in 1976 survived into the winter. At the onset of the 1977 summer rains, a population estimated at 30 birds was found near the 1976 release sites in Altar Valley on the Buenos Aires Ranch. On October 4, 1977, Dobrott found a pair of masked bobwhites with at least three chicks. These observations constituted the first demonstration of significant over winter survival, and the first confirmed observation of progeny produced and reared in the wild by a fully independent stock of propagated origin.

Annual releases from 1975 to 1979 on the Buenos Aires Ranch produced a sizable wild population. Substantial natural productivity was documented, over winter survival was good, and the number of calling males increased from 21 in 1977, to 54 in 1978 and eventually to a peak of 74 in 1979 (Goodwin 1982). Thereafter intensive grazing, combined with summer

drought, sharply reduced the population (Goodwin 1981). Only nine birds were detected in 1984 (Levy and Levy 1984, Ough and deVos 1984). This experiment substantiated the feasibility of reestablishing the masked bobwhite, and provided valuable insight into habitat requirements of the bird. These events showed the vulnerability of quail to even moderate grazing pressure and demonstrated the necessity for a refuge managed exclusively for masked bobwhite.

Releases were made at three locations (Fig. 2, Table 2) from 1980 through 1982 (Goodwin 1981, Reyes, pers. comm.) to evaluate the suitability of ranges in Sonora that have undergone brush removal. The success of these releases is uncertain (Mills and Reichenbacher 1982) due to intensive livestock grazing at all three sites.

Potential Management Sites:

The original Masked Bobwhite Recovery Plan delineated areas believed to be most suitable for establishing a masked bobwhite management area in the United States (Brown and Ellis 1977) including portions of the southern Santa Cruz and Altar valleys (Fig. 1). The areas within the Santa Cruz Valley were not available and were believed to need extensive habitat rehabilitation. However, the Buenos Aires Ranch in the Altar Valley had achieved success reintroducing masked bobwhites and was a viable alternative. Therefore, the Buenos Aires Ranch was considered the first priority area for permanent protection for the masked bobwhite.

Refuge Acquisition:

In 1985, after nearly two years of controversy and public debate, the Buenos Aires Ranch was acquired by the USFWS as a refuge for the masked bobwhite in Arizona. The BANWR consisted of 112,000 acres (45,360 ha) of patented, state, and federal lands. Although reports persisted of masked bobwhites in the Altar Valley, they could not be verified (Brown 1989). It appeared that the introduced population disappeared despite moderate and above-average summer precipitation between 1981 and 1984. The acquisition of the BANWR accomplished a major objective of the 1984 recovery plan.

Recent Restoration Efforts:

United States

Recovery efforts in the U.S. have focused on reestablishing and monitoring reintroduced masked bobwhites on the BANWR. From 1985 to 1994, 21,942 masked bobwhites were received from Patuxent Wildlife Research Center and 17,438 birds (79%) were released on BANWR (Table 3).

Table 3. Masked bobwhites received and released on Buenos Aires National Wildlife Refuge, 1985 to 1994

Year	Received	Released	Percent
1985	954	853	89
1986	2070	1699	82
1987	2357	2171	92
1988	2313	1841	80
1989	1696	1180	70
1990	2693	2167	80
1991	2753	2317	84
1992	2278	1773	78
1993	2531	1930	76
1994	2288	1507	66
Totals	21942	17438	79

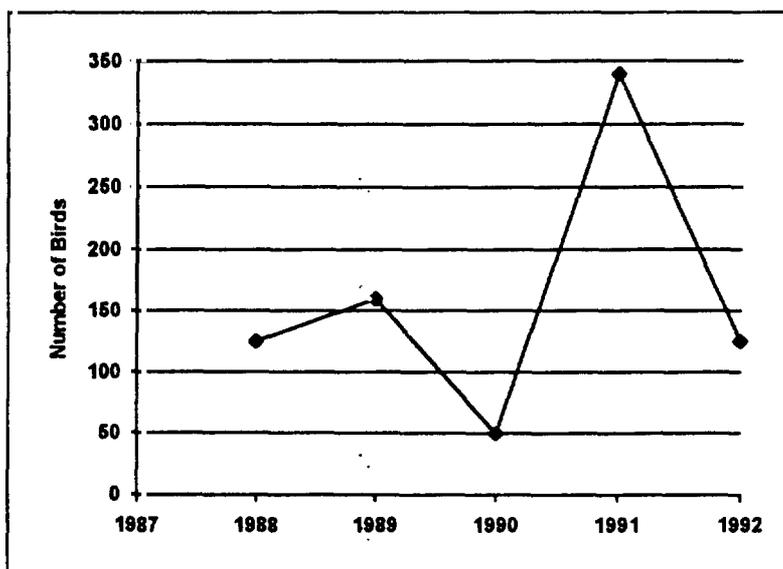
Two release methods have been used on the BANWR since 1985. The primary method included the use of the foster parent/adoption program (Ellis et al. 1978). An average of 2,500 masked bobwhite (2 weeks old) were received from Patuxent Wildlife Research Center from July 1 through September each year.

Approximately 80% of the stock received from Patuxent have been released annually since 1985. All released stock were marked by leg or wing bands. Release strategies included placing foster-parented broods of 4-5 weeks of age in areas of the refuge that provided the best brood rearing habitat. Timing and amount of summer rainfall often dictated the locations available for release. Releases were concentrated within suitable areas allowing stock the opportunity to exchange individuals within the population through the winter.

The second release method included the use of older stock that were held and released as immatures and adults during the winter and spring. These birds were released in coveys of 10 birds each. All release stock had the opportunity to mature on the ground with wild Texas bobwhites. The release periods were timed to avoid peaks in raptor migrations.

Monitoring included both winter and summer surveys (Fig. 4 and Fig. 5). Winter surveys included the use of trained bird dogs to locate bobwhite coveys. Trapping was then initiated to obtain information on condition of released birds, distance traveled from release sites, and presence of any wild-reared birds. Summer call count surveys were conducted during the peak calling period of mid-August.

Figure 4.
 Number of masked
 bobwhite found in
 winter surveys at
 BANWR 1988-1992



Winter and Spring surveys in 1991 revealed an over wintering population of 31 coveys (333 bobwhites) within a 4,000 ha study area (Dobrott 1991). However, without supplementation, this population began to disperse and decline in 1992 (Drobrott 1992). It was suggested that limited abundance and variety of winter foods was responsible for the decline.

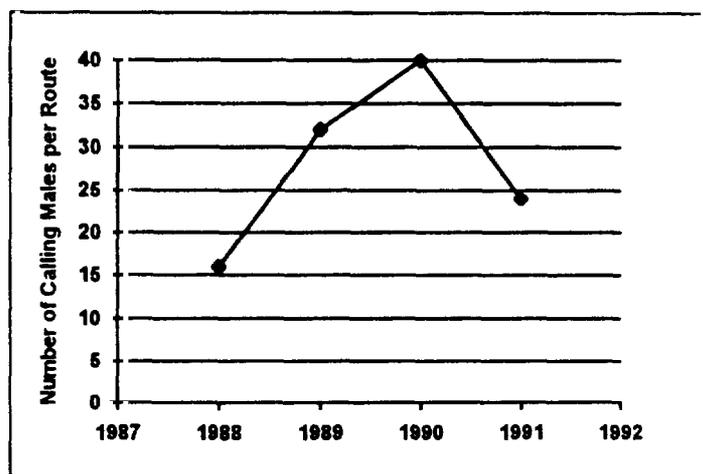


Figure 5.
 Number of calling males heard
 during summer surveys on
 BANWR, 1987-1992

Until the summer of 1990, the BANWR received insufficient precipitation to provide adequate brood habitat or winter foods. Summer surveys revealed up to 43 calling males in 1990 and limited reproduction has been documented each year since 1988 (Fig. 4 and Fig. 5).

These reintroduction efforts were not as successful as anticipated. Refuge managers thought that if the BANWR was allowed to rest and recover from the impacts of grazing, and masked bobwhites were released into suitable, high potential habitat, that a self-sustaining population would result. It has become apparent that active management actions will be necessary to successfully support reintroduced pen-reared birds (and wild Texas bobwhites) through the winter. After considering bobwhite management practices in south Texas, such as discing and food plot planting, it now seems reasonable to apply similar actions to the BANWR.

Research conducted on BANWR included masked bobwhite home range studies (Simms 1989), winter monitoring studies (Dobrott 1991, 1992), and vegetation studies. Parental behavior of bobwhite foster parents was studied to determine the effects of testosterone on adoption success (Vleck and Dobrott 1993).

Although limited habitat management has been implemented on BANWR, approximately 11,000 ha have been prescription burned to enhance masked bobwhite habitat. Other projects include restoring 2 ha of desert legumes and supplementing cover on 20 ha (i.e., brush piles and mesquite half cutting).

Mexico

Recovery efforts in Mexico have included masked bobwhite population and habitat monitoring and establishing cooperative programs with agencies, institutions, and ranchers. The future of the masked bobwhite in Sonora depends largely on cooperation of the people who manage the land. Great progress has been made in developing positive management attitudes of ranchers whose activities directly influence masked bobwhite survival.

Cooperative programs have improved the prospects for recovery of the masked bobwhite in Sonora. In 1990, shortly after receiving the lead for the masked bobwhite, BANWR entered into an agreement with The Nature Conservancy to coordinate biological work in Mexico with Centro Ecologico de Sonora in Hermosillo. This agreement provided the opportunity to work directly with Mexican biologists who were assigned specifically to the masked bobwhite project. It also implemented a better means of communicating with the landowners associated with masked bobwhite habitat. This program provided an important base of communication and cooperation previously not available.

G. Strategy of Recovery

Perhaps the most important step toward the recovery of the masked bobwhite in the United States was the establishment of BANWR in 1985. A management area, within the historic range of the bird, is now in place and managed to provide habitat recovery. A reintroduction program has been initiated with limited but encouraging success. Information on habitat requirements of masked bobwhite has increased and recommendations are being made for

habitat management. Recent studies suggest that much can be done to improve existing habitat to provide critical elements that may be lacking, such as preferred food-producing legumes and the correct cover structure. A variety of methods are being considered for enhancing habitat. This revision of the Recovery Plan addresses the strategies now believed necessary to reestablish self-sustaining, wild masked bobwhite populations. A revision of the recovery plan was essential because of the acquisition of the BANWR, supplemental information on habitat requirements of masked bobwhite, and changing events in Mexico that impact this species recovery. This revision addresses the following:

1. Maintenance of two captive populations at widely separated sites, to provide continued production for reintroduction and genetic variability.
2. Revised population objectives.
3. Habitat management needs on BANWR.
4. Evaluation of captive propagation and release techniques.
5. Research on food habits, mortality, dispersal and other natural history parameters.
6. Recommendations for preserving and managing existing masked bobwhite populations, and establishing two new populations in Mexico.
7. Conduct population viability analyses and identify minimum viable population sizes necessary for recovery. Locate another appropriate release site in the U.S. and upon recovery of the BANWR population, reestablish a second population.

II. RECOVERY

A. Objectives and Criteria

Objective:

The primary objective set forth in the 1984 Revised Plan was to “establish and permanently protect habitat for three or more self sustaining masked bobwhite populations in Arizona, and permanently protect or re-create habitat suitable to maintain or reestablish one or more populations at a similar level of abundance in Sonora, Mexico (U.S. Fish & Wildlife Service 1984).” A part of this objective has been accomplished with establishment of the BANWR in 1985. The goal of establishing 3 or more populations in the United States, in addition to one located on the refuge, may be unrealistic. The availability of suitable habitat outside of the refuge is limited and possibly nonexistent. However, opportunities for reintroduction within suitable historic range in other areas of Arizona should not be ruled out because it may be possible to locate at least one other suitable release site in southern Arizona.

In Mexico, increased cooperation and renewed interest in masked bobwhite recovery has resulted in important management actions on key ranches that offer great possibilities for preserving and increasing remaining populations in Mexico. Options for reintroducing masked bobwhites to other areas in Sonora are increasing also.

The 1984 Plan defined a sustainable population to be “an average of 200 calling males (or about 500 masked bobwhites) which, without supplementation, has maintained its numbers for at least 5 years and has never fallen below 50 calling males (the averaging period would not

begin until the year following the last release of captive-bred birds).” The figure of 200 calling males assumes the following: 1) 500 individuals are necessary in a population to minimize the likelihood of inbreeding depression (Denniston 1978, R. Simms, pers. comm. in Goodwin 1982); 2) the species to be peripheral to the United States where it is influenced greatly by widely fluctuating summer rainfall; therefore, large annual population fluctuations are likely; and 3) a count of 200 calling males suggests a total population of about 500 birds.

The number of calling males in a measurable parameter, but conversion to an estimate of actual population size is difficult. Assuming that the population consists of 60 percent males (Rosene 1969), all males in the population are calling, and all calling birds are detected, the actual population would be 1.67 times the number of calling birds. Since the latter two assumptions are probably not realistic, it is likely that the actual population size is 2-3 times the number of calling males detected. Thus, a population containing 200 calling males probably consists of about 500 adult birds at the onset of the breeding season, around July 1.

For the purpose of the 1984 Plan, the 50-200 calling males standard (maximum population size-600 quail) defined a self-sustaining population. In developing a realistic population size objective, it must be remembered that the above population estimation method was derived from research conducted on other subspecies of bobwhite in the southeastern United States (Rosene 1969). Moreover, Gee (pers. comm. 1993) recently expressed doubt that 500 individuals of an “r-selected species” adequately represents self-sustainability. However, at this time it is not possible to establish a reliable standard for population self-sustainability because a complete study of the life history and population dynamics of the masked bobwhite

has not been conducted. Although population estimates for the three Sonoran populations and the BANWR population are currently available, estimates of important demographic mechanistic processes such as survival, mortality, recruitment, colonization, immigration, and emigration rates (Gilpin and Soule' 1986) are lacking. Although considerable information has been gathered since the Plan was revised in 1984, much information must still be gathered to ensure that the masked bobwhite does not become extinct in the wild. Therefore, it is critical that research projects designed to obtain the baseline demographic information necessary to determine appropriate minimum population sizes in both Sonora and Arizona be initiated.

For this plan, it is sufficient to use the 1984 figure of 200 calling males as an interim population objective until better information is available. Data regarding the increasing masked bobwhite population in Sonora (Rancho El Carrizo) would help tremendously in clarifying BANWR population objectives.

Revised Objective:

Reestablish and maintain a viable population of masked bobwhite on the BANWR while not excluding other possible sites that may exist outside the refuge boundary. Therefore, primary recovery in Arizona is to establish and maintain a viable self-sustaining "population" of at least 500 birds on the BANWR. If available, a second site will be selected and efforts made to establish a self-sustaining population there also, but priority will be given to establishment of the BANWR population. Emphasis will be placed on preserving remaining populations in Mexico and their restoration to optimum population levels sustainable by available habitat. Two or more viable populations of masked bobwhite are to be restored in Sonora, Mexico.

Criteria:

The masked bobwhite will be considered for reclassification from endangered to threatened when four separate, viable populations are established (consisting of two populations in the United States and two or more in Mexico) and have been maintained for 10 consecutive years. The criteria for full delisting the species are not known at this time. The earliest estimated date for downlisting is 2007.

B. Narrative Outline for Recovery Actions Addressing threats

1. Establish and maintain at least two captive populations
 - 1.1 Maintain one captive population as a gene pool
 - 1.2 Maintain second captive population to produce birds for wild release
 - 1.3 Maintain and enhance gene pools
 - 1.31 Monitor
 - 1.311 Captive flock
 - 1.312 Chicks to be introduced
 - 1.313 Wild populations(s)
 - 1.4 Construct a new captive breeding facility
2. Establish two separate viable masked bobwhite populations in Arizona
 - 2.1 Maintain and enhance population on BANWR and other non-indigenous site
 - 2.11 Reintroductions
 - 2.111 Order production of birds required for introduction
 - 2.112 Finalize selection of release site
 - 2.12 Release birds
 - 2.13 Monitor populations
 - 2.2 Population management
 - 2.21 Conduct population viability analysis

- 2.22 Determine minimum viable and effective population size
- 2.3 Habitat management
 - 2.31 Develop and implement habitat management plan for BANWR
 - 2.311 Discing
 - 2.312 Food plots
 - 2.213 Half-cutting
 - 2.314 Chaining
 - 2.315 Grazing
 - 2.316 Fire
 - 2.317 Water
 - 2.32 Evaluate habitat management
 - 2.321 Identify management alternatives. Prioritize on cost benefit basis
- 2.4 Select preferred management alternative
 - 2.41 Determine habitat evaluation criteria
 - 2.42 Implement preferred alternative
- 2.5 Research and information needs
 - 2.51 Habitat requirements
 - 2.511 Conduct home range studies
 - 2.512 Perform habitat suitability analyses
 - 2.513 Determine seasonal habitat requirements
 - 2.514 Determine the effects of various habitat management techniques on bobwhite habitat use
 - 2.515 Implement native food plant restoration program
 - 2.516 Evaluate potential for competition between quail species
 - 2.517 Construct habitat model for BANWR
 - 2.52 Food habits
 - 2.521 Identify seasonal dietary preferences
 - 2.5211 Conduct fecal analysis
 - 2.5212 Determine crop contents of salvaged birds
 - 2.53 Population dynamics
 - 2.531 Estimate minimum viable population size

- 2.532 Determine seasonal mortality rates
- 2.533 Evaluate various census techniques
- 2.54 Captive propagation and release
 - 2.541 Evaluate specific release techniques
 - 2.542 Determine genetic diversity and increase heterozygosity in captive population
- 3. Maintain existing masked bobwhite populations in Sonora, Mexico, and reestablish two or more viable populations in Mexico
 - 3.1 Population analyses
 - 3.11 Determine population structure and stability
 - 3.111 Monitor
 - 3.12 Survey potential habitats for new populations
 - 3.13 Select introduction sites
 - 3.2 Habitat protection
 - 3.21 Determine habitat availability and stability
 - 3.22 Locate new release areas and release birds
 - 3.221 Contact landowners
 - 3.222 Conduct habitat suitability analyses
 - 3.23 Establish a permanent refuge for masked bobwhites
 - 3.3 Develop habitat management plans
 - 3.31 Arrange cooperative agreements with land owners
 - 3.4 Maintain and improve habitat
 - 3.41 Address grazing issues
 - 3.42 Identify other compatible habitat management techniques
 - 3.5 Reintroductions
 - 3.51 Evaluate potential release areas
 - 3.511 Develop criteria
 - 3.52 Develop a release plan

- 3.54 Monitor survival
- 3.6 Research needs
 - 3.61 Identify seasonal habitat requirements
 - 3.611 Habitat model
 - 3.612 Conduct home range studies
 - 3.613 Measure effects of habitat management
 - 3.614 Comparative habitat analysis
 - 3.62 Food habits
- 4. Public relations
 - 4.1 Education
- 5. Cooperative partnerships
 - 5.1 Provide technical assistance
 - 5.2 Support research
- 6. Publication costs
- 7. Establish and maintain media relationships

C. Narrative Outline For Recovery Actions

1. The success of the masked bobwhite recovery effort is currently heavily dependent on supplementation of captive-reared chicks to wild populations. Therefore, at least two captive populations of masked bobwhites, each consisting of 500-1,000 birds should be maintained at different geographic locations to ensure that the gene pool survives in the event that one population succumbs to a catastrophic occurrence.
 - 1.1 Maintain one captive population at Patuxent Wildlife Research Center or other comparable facility. The captive birds at Patuxent comprise the only captive breeding population currently in existence. Therefore, this population should be maintained to ensure that chicks remain available for release to the wild as well as to preserve the species gene pool.

- 1.2 Maintain second captive population at a site well removed from Patuxent and BANWR. Since the captive population at Patuxent is the only one in existence, a single catastrophe could destroy or significantly decimate the gene pool. Such an event would greatly hamper recovery efforts and simultaneously increase the risk of extinction. It is therefore essential that another captive breeding population be established and maintained at a site distant from Patuxent and BANWR.
 - 1.3 Monitor gene pools. Captive population gene pools should be monitored on a regular basis to ensure that sufficient genetic diversity is maintained. Regular monitoring should permit trained personnel to determine when infusion of new genetic material is necessary. Wild birds can then be captured and added to captive populations to ensure that the proper levels of heterozygosity are maintained. An estimated 40 wild birds should be added to each captive population at 3 to 4 year intervals.
 - 1.4 Construct a new captive breeding facility. The current captive breeding facility at the Patuxent Wildlife Research Center is more than 30 years old. Major physical improvements are needed to improve propagation, rearing and maintenance. Disease and parasite prevention and control is another primary concern. Construction of a new facility would alleviate these problems. A single building should be constructed to house all of the equipment necessary to propagate and raise masked bobwhites. It should be built to improve the efficiency of the operation as well as sanitation.
2. Establish two separate viable masked bobwhite populations in Arizona. One of the primary goals of the masked bobwhite recovery effort is to establish viable populations in the United States. The BANWR was established for this purpose and an array of habitat and demographic management techniques have been implemented, or will be implemented, to restore a self-sustainable population to the southern Altar valley. Another site in Southern Arizona deemed suitable for re-establishment of the species will be located when a viable population is established on BANWR.

- 2.1 Reintroduction of masked bobwhites to suitable habitats in Arizona and Mexico is critical to re-establishment efforts. Wild populations must be supplemented with reintroduced birds because annual recruitment and survival rates among the BANWR and Sonoran populations do not yet appear to offset mortality rates. Additionally, reintroductions will eventually be necessary when other re-establishment locations are identified.
- 2.11 Maintain captive flock. Captive flocks should be maintained indefinitely to provide sufficient release stock for operations in the United States and Mexico.
- 2.12 Release birds. A minimum of 2,000 birds per year should be released in suitable habitat. Masked bobwhite chicks and/or juveniles should be released as broods in areas that offer appropriate food and cover which maximizes survival. Timing of releases should coincide with the summer rainfall season and avoid periods of raptor migrations. Releases should continue until natural reproduction rates indicate the population is self sustaining.
- 2.13 Monitor populations. Annual population trend data can be gathered by counting calling males in summer. A correction must be made for calling Texas bobwhites in the population. Each year's release program should be evaluated by conducting follow-up surveys in winter and spring. Winter surveys provide information on the success of the release techniques. Spring surveys provide information on the number of birds entering the breeding season. When possible, surveys should include the use of trained bird dogs or other appropriate census techniques. Radio-telemetry will also be utilized to directly monitor the fate of released birds and thereby provide additional information on the success of the reintroduction program.
- 2.2 Population management. Masked bobwhite populations must be managed in a manner that ensures their viability in natural habitats. Consequently, techniques that provide relevant demographic and habitat carrying capacity data should be implemented.

2.21 Conduct population viability analysis. A population viability analysis (Boyce 1992) for masked bobwhites should be conducted to determine the expected probabilities for extinction. Such an analysis would help define the scope of effort necessary to recover the masked bobwhite. A proper analysis will require basic masked bobwhite life history data which currently is either very limited or nonexistent. Therefore, before population viability analyses can be conducted it will be necessary to obtain such basic information as longevity, survival, and recruitment rates, number of eggs produced per year, fertility, hatchability, brooding success, genetic diversity, heterozygosity, and identification of major mortality factors (Gee pers. comm. 1993). The most effective way of obtaining data is to initiate simultaneous research activities on the wild populations in both Sonora and Arizona as soon as possible.

2.22 Determine minimum viable and effective population size. Effective population size should be determined. Current knowledge of the masked bobwhite precludes the ability to predict the minimum population size required to sustain itself. Habitat studies should be conducted to measure the amount of suitable winter and summer habitat on the refuge. Data from these studies coupled with predicted population densities will aid in determining the scope of action required to restore the masked bobwhite to the refuge. A more complete understanding of the population dynamics of the masked bobwhite in Mexico would aid in determining refuge population objectives.

2.3 Experimental habitat management. Proper habitat management is critical to re-establish self-sustaining masked bobwhite populations. Habitat management should however, be applied on an experimental basis and therefore adhere to rigorous experimental designs thus enabling investigators to scientifically evaluate the effects of specific management practices on quail habitat use. Those practices identified as creating habitat conditions beneficial to masked bobwhite production can then be applied on a larger scale.

2.31 Implement experimental habitat management program. Habitat management should be implemented as soon as possible in order to support birds that may need supplemental food reserves to hold and carry them through the winter. An initial experimental area of approximately 3,000 acres (1,215 ha) has been identified on the refuge. This area was selected due to its proximity to occupied habitat and the potential for experimental management. A variety of habitat management techniques developed for other subspecies of northern bobwhite should be tested on the refuge. Experimental actions will be subject to, and in accordance with, the constraints of the Endangered Species Act and the Antiquities Act.

2.311 Discing. Discing is an effective tool for bobwhite habitat management in the southeastern United States but needs to be tested in the southwest. In the southeast, timely discing will stimulate production of a variety of food- and insect-bearing plants important to bobwhites. Discing in long narrow strips results in a break in plant succession and provides plant diversity and edge. This technique should be tested in sandy loam and deep loam soils where maximum response would be expected from summer rains.

2.312 Food plots. Experimental food crops should be planted in conjunction with discing. Restoration of native desert legumes should be attempted along with supplemental plantings of various annual grain crops. Food plots should be located in areas identified as potential masked bobwhite wintering areas.

2.313 Half-cutting. Vegetation should be managed to provide suitable vertical and horizontal structure preferred by bobwhites. Mesquite half-cutting (pruning) should be conducted when canopy heights need to be reduced and where cover is limited.

- 2.314 **Chaining.** Habitat composed of large expanses of dense woody cover that has matured beyond what is useful to masked bobwhites, can also be chained to lower vertical cover as well as to set-back plant succession. Unlike half-cutting, chaining can be applied on a large area over a short period of time.
- 2.315 **Grazing.** Overgrazing has been implicated as a major reason for the extinction of the masked bobwhite in the United States and responsible for serious population declines in Sonora, Mexico. However, carefully monitored, light grazing may prove useful in managing quail habitat when and where range conditions have recovered to appropriate levels. Proper grazing management has been shown to improve herbaceous habitat conditions for bobwhites in South Texas (Guthery 1986). Properly applied livestock grazing provides the diversity of range condition classes favored by bobwhites. Cattle production is the primary livelihood of landowners that control range lands that harbor masked bobwhite populations in Sonora. Therefore, proper grazing management is essential to the recovery of the species in Mexico. Grazing studies conducted on BANWR would not only benefit recovery efforts on the refuge but in Mexico as well. Prescribed grazing should therefore remain an option for managing masked bobwhite habitat if conditions and management objectives warrant.
- 2.316 **Fire.** Prescribed burning is a management tool that provides an economical means for controlling woody plant species encroaching on grassland ecosystems. Fire has been absent from the refuge grassland for about 80 years. Fire is believed to be an important factor in controlling mesquite invasion and stimulating growth of important desert legumes. Prescribed burns should be conducted on a rotational basis to produce a mix of habitats in various stages of plant

succession. The objective should be to produce a mosaic pattern of habitat types that are easily accessible within bobwhite home ranges.

2.317 Provide supplemental water. Bobwhites typically fulfill most of their daily water requirements via the foods they consume, however the effects of prolonged drought on food supplies, may inhibit reproduction (Guthery 1991). Sprinkler systems have been installed in south Texas to mitigate the effects of drought on bobwhite populations, and the results have been encouraging (Howard pers. comm. 1992). The captive masked bobwhite population appears to function at optimal levels when exposed to high humidity and provided with a great deal of free water (Gee pers. comm. 1993). Since the masked bobwhite population has yet to reach self-sustainability in Arizona, any technique that maintains or elevates reproduction, and suppresses mortality, should be evaluated. Therefore, a sprinkler system should be installed on an experimental basis to determine if irrigation stimulates food production and elevates masked bobwhite reproduction and survival above that which occurs on control areas lacking supplemental water.

2.32 Evaluate habitat management. Habitat should be monitored to determine effectiveness of various management techniques. A variety of monitoring techniques are available for measuring vegetative response to management. Permanent and temporary vegetation transects should be established for this purpose. Appropriate experimental designs should be employed to insure sound data collection and analysis.

2.321 Identify cost effective management.

2.33 Develop a habitat management plan for BANWR. The reintroduction program has achieved only limited success (Dobrott 1992) without an active habitat management program. With the exception of prescribed burns and mesquite

half-cutting in a very small area, little has been done to enhance habitat conditions for masked bobwhite on the refuge. After BANWR was purchased, it was assumed that allowing the vegetation to recover from the effects of livestock grazing would recreate conditions suitable for masked bobwhites. Recovery has not occurred. Refuge studies suggest that habitat deficiencies such as food and cover lead to long range movements of bobwhite coveys (which may result in mortality) during the winter (Dobrott 1992). The variety and abundance of bobwhite food producing plants seems limited, even within the suitable, high potential areas previously identified on the refuge. Aggressive habitat management should begin by developing a habitat management plan that re-establishes and maintains adequate winter habitat needed to support a viable masked bobwhite population on the refuge.

2.4 Select management areas. Potential management areas should be identified and selected for treatment. All areas should be evaluated for their management potential and suitability for masked bobwhites.

2.41 Habitat evaluation criteria. Develop criteria for evaluating masked bobwhite habitat site-suitability. Factors to consider are elevation, temperature extremes, soil types, rainfall, appropriate food and cover, and proximity to other bobwhites. The appropriate criteria should be developed based on existing habitat measurements previously collected on the Refuge and in Mexico.

2.42 Investigate potential habitats on the BANWR. All potential masked bobwhite ranges on the refuge should be located and evaluated by the above criteria. Releases should not be conducted in areas that lack appropriate habitat conditions. Some presently unsuitable areas may become suitable for masked bobwhites as a consequence of management techniques applied.

2.5 Research and information needs. The current information base on masked bobwhite ecology is meager. Though a few research projects were undertaken on the

BANWR in the past, these projects were of short duration (1-2 yr) and limited focus (Goodwin 1981, Simms 1989, Vleck and Dobrott 1993). Information for the Sonoran population is even more limited, confined largely to data obtained from periodic demographic and habitat surveys (Tomlinson 1972b, Mills and Reichenbacher 1982, U.S. Fish and Wildlife Service 1984). Comprehensive, long-term studies are needed to examine critical aspects of masked bobwhite ecology, life history, management and propagation both in Arizona and Sonora. These research projects should be based on rigorous experimental designs that yield statistically valid results.

2.51 Habitat requirements. Determine the habitat requirements necessary to sustain the BANWR population. Determine the factors that limit production and survival of masked bobwhites on the refuge.

2.511 Conduct home range studies. Continue home range studies in Arizona to measure the response of reintroduced masked bobwhites to various habitat manipulations.

2.512 Perform habitat suitability analyses. Habitat suitability should be determined before re-establishment activities are applied to specific habitats. Consequently, habitat suitability analysis should be performed on habitats that are being considered as release sites and before these habitats are modified.

2.513 Determine seasonal habitat requirements. Continue studies of masked bobwhite seasonal habitat requirements. Preliminary information indicates that the quality of winter habitat exerts an important influence over annual survival rates of masked bobwhites. In addition, the quality of habitat used during the breeding season is likely an important influence on annual survival rates of masked bobwhites. In addition, the quality of habitat used during the breeding season is likely an important factor influencing productivity. Currently, specific

information regarding the quantity and quality of specific seasonal habitat components remains unknown, and thus warrants investigation.

- 2.514 Determine effects of various habitat management techniques on masked bobwhite habitat use. Evaluate the effects of discing, burning, chaining, half-cutting, food plots (non-native), sprinkler systems and grazing on masked bobwhite habitat use.
- 2.515 Native plant restoration. Native vegetation determined to be important sources of masked bobwhite food should be restored or, if present in low densities, encouraged to increase in Arizona.
- 2.516 Evaluate potential for competition between quail species. Brown (1989) reported that masked bobwhites and Gambel's quail have distinct habitat preferences, and thus habitat partitioning occurs. However, cursory observations indicate that masked bobwhites and Gambel's quail are currently utilizing similar habitats on selected areas of the Buenos Aires NWR. Since Gambel's quail are typically larger than masked bobwhites, occur in larger coveys and are more abundant on the refuge than masked bobwhites, potential exists for competition between the two species which likely does not favor masked bobwhites. Most, if not all, of the habitat management practices that will be implemented to increase masked bobwhite populations will probably also benefit Gambel's quail. Therefore, habitat competition between masked bobwhites and Gambel's quail should be examined and verified before habitat management is implemented on a large scale.

- 2.517 Construct habitat model for BANWR. Construct a habitat model using results from quail-habitat interaction studies to facilitate future habitat management planning.
- 2.52 Food habits. Conduct bobwhite food habit studies to determine effectiveness of habitat management.
- 2.521 Identify seasonal dietary preferences. Develop an understanding of the foods being used seasonally on the refuge.
- 2.5211 Fecal analysis. Perform fecal analyses to determine seasonal dietary preferences. Masked bobwhite droppings collected at roost sites should be analyzed for seed and insect content. Sampling should occur in Arizona and Sonora and the results compared.
- 2.5212 Texas bobwhite crop contents. To supplement food habits data obtained from fecal analysis, the crop contents of Texas foster males should be analyzed. Foster male diets likely mirror those of their masked bobwhite broods, so the contents of Texas bobwhite crops would be indicative of the food habits of masked bobwhites. Consequently, foster males should be collected during late spring-early summer, while quail are still in coveys, and their crop contents analyzed.
- 2.53 Population dynamics. Assess techniques for estimating population size and distribution and incorporate appropriate post-release studies to gather information on population movements.

- 2.531 Estimate minimum viable population size. Currently no information is available on the minimum population size necessary to maintain a self-sustaining population of masked bobwhites. Therefore, a study should be conducted to estimate the effective density necessary to sustain a self-sustaining quail population.
- 2.532 Determine seasonal mortality rates. In addition to a lack of information concerning minimum viable population size, knowledge of seasonal age and sex specific mortality rates are limited. Research should be conducted to determine these mortality rates.
- 2.533 Evaluate various census techniques. A number of census techniques have been used in the past to estimate masked bobwhite densities, however none have been critically evaluated to determine method-specific accuracy and precision. Therefore, research should be initiated to address these shortcomings. Techniques to be evaluated should include: line transects, mark-recapture and bird dog-induced flushing counts.
- 2.54 Captive propagation and release. Captive propagation and release of masked bobwhite chicks has been an important aspect of the recovery effort and should continue until the species is delisted.
- 2.541 Evaluate specific release techniques. Releases involving broods adopted by vasectomized Texas bobwhite males should continue, however brood survival should be monitored periodically to determine the success of this technique. Suspected causes of mortality could thus be identified and appropriate measures then implemented to mitigate mortality events. Broods should also be held for variable time intervals with their foster males to determine if longer periods of conditioning in flight pens enhances brood survival. Additionally,

pairing of masked bobwhite hens and vasectomized Texas males should be attempted in an effort to induce infertile egg-laying and then subsequent replacement of infertile eggs with fertile eggs produced by the captive population. It is possible that chicks incubated and raised by pairs in flight pens over variable time intervals may experience higher rates of survival upon release. Therefore, the efficacy of paired adoption and release should be evaluated as well as the traditional foster male technique.

2.542 Maintain genetic diversity and increase heterozygosity in captive populations. One of the primary reasons for maintaining the genetic diversity of a captive breeding population is to preserve as much of the wild founders' genetic variation as possible (Ralls and Ballou 1992). This is generally accomplished by selecting for heterozygosity. With regard to masked bobwhite, genetic diversity refers to the number of alleles for each gene loci in the population, while heterozygosity refers to the number of individual birds in the population that have 2 different alleles on a gene loci (Gee pers. comm. 1993). The genetic variation of the captive masked bobwhite population is currently acceptable. However, infusion of new genetic material from one of the wild Sonoran populations will be necessary during the next few years. Before wild birds are captured and added to the captive population, a genetic reconnaissance should be conducted on all of the Sonoran populations to determine the heterozygosity of each population as well as the degrees of genetic similarity between the wild populations and the captive population. Wild birds selected for addition to the captive population could then be removed from the most genetically distant wild population or from the population displaying the highest degree of heterozygosity.

3. **Maintain existing masked bobwhite populations in Sonora, Mexico and reestablish two or more viable populations.** Masked bobwhite populations currently existing in Sonora should be maintained and efforts should be made to reestablish two or more additional populations in suitable habitats.

3.1 **Population analyses.** Analyze the present range, density, habitat condition, and trends of all populations in Sonora. There may be outlying groups of masked bobwhites that are either remnant populations of subpopulations which have emigrated from the core population (Dobrott 1992). These groups need to be located, monitored and management strategies developed to promote genetic exchange among the existing populations.

3.11 **Population monitoring.** Continue to monitor population trends and habitat conditions. Call routes should be conducted during the peak of calling activity in August. At least two weeks annually should be spent censusing known populations and locating any other breeding satellite populations.

3.12 **Survey potential habitats for new populations.** Evaluate habitats recently occupied by masked bobwhites to determine if, through management, these areas may again support a reintroduced population.

3.2 **Habitat protection.** Encourage the recognition of protected areas by state and private entities on behalf of the masked bobwhite by developing and following through with partnership programs. Technical assistance and guidance through The Nature Conservancy stimulated great progress in the development of educational and research oriented programs that promote habitat protection and environmental awareness. Programs such as these are the key to securing and protecting masked bobwhite habitat in Mexico.

- 3.21 Monitor habitat. Continue to monitor habitat to ensure that proper conditions are maintained to support self-sustaining masked bobwhite populations.
- 3.22 Locate new release areas. Locate release areas that fulfill the criteria (plan objective) for suitable quality habitat.
 - 3.211 Contact landowners. Contact landowners that have management control over occupied and potential masked bobwhite habitat. Educate and encourage ranchers to participate in the recovery of this species.
 - 3.222 Conduct habitat suitability analyses. Determine if adequate habitat is available to sustain a viable population of masked bobwhites. Identify summer and winter habitats needed to maintain self-sustaining populations.
- 3.23 Establish a permanent refuge for masked bobwhites. Existing masked bobwhite populations in Sonora occupy private land. The species current welfare is therefore dependent on the land management decisions of cattle ranchers. Excessive grazing or conversion of native habitat to buffleggrass, could destroy significant portions of the remaining habitat and thereby threaten the masked bobwhite with extinction in Mexico. Efforts should be made to establish a permanent masked bobwhite refuge in Sonora where critical habitat could be protected and managed specifically for the species.
- 3.3 Develop habitat management plans. Offer ranch owners assistance in developing habitat management plans.
 - 3.31 Arrange cooperative agreements. Develop cooperative agreements with private landowners in Sonora, Mexico. This task would be best accomplished through Centro Ecologico de Sonora (CES).

- 3.4 Maintain and improve habitat. This effort will require technical support from the USFWS and cooperative programs with CES.
- 3.41 Address grazing issues. Determine grazing patterns and intensities that are compatible with masked bobwhite recovery. Although livestock grazing has caused the near extinction of the species, carefully controlled grazing has increased food availability for masked bobwhites on Rancho El Carrizo (Dobrott 1992). As mentioned earlier, livestock grazing is the primary source of income to Sonoran ranchers. Consequently, grazing levels compatible with masked bobwhite production are essential if the species is to successfully be restored to Mexico.
- 3.42 Identify other compatible habitat management techniques. Recommend various habitat rehabilitation techniques such as disking, brush canopy reduction, and supplemental food plot plantings. Experimental grain sorghum plantings in 1991, on Rancho El Carrizo, proved to be an effective way of providing supplemental food for high densities of over-wintering masked bobwhites.
- 3.5 Reintroductions. The reintroduction of masked bobwhites should be considered in unoccupied, suitable habitat after the appropriate preparations have been made.
- 3.51 Evaluate potential release areas throughout the masked bobwhite historic range. Potential release areas should be evaluated using habitat evaluation criteria previously utilized.
- 3.511 Develop criteria. Habitat evaluation criteria should be developed using information collected from various vegetation measurements obtained in Sonora. The minimum area required for reintroduction should

include at least 5,000 acres (2,025 ha). The area should contain sufficient winter habitat adjacent to summer range (within 3 km).

- 3.52 **Develop a release plan.** The release plan should describe release stock production needs, release strategies, scheduling and coordination with Mexican authorities. When wild populations reach self-sustainable levels, the release plan should consider supplementing the captive release stock with wild birds from Sonoran and Arizona populations. Translocating wild birds should expedite re-establishment efforts because wild individuals would likely have higher survival rates than their captive counterparts.
- 3.53 **Release birds. Implement release plan.** A minimum of 2,000 birds should be released per year for three years or until over winter survival rates preclude the necessity for further supplementation.
- 3.54 **Monitor survival.** Post-release survival should be monitored during winter and spring. Spring surveys to measure over winter survival will provide the most information in determining overall success. Summer call count surveys should be conducted during the peak calling period.
- 3.6 **Research needs.** Definitive work on the life history of the masked bobwhite in Sonora is limited (Tomlinson 1972a). Key information such as food habits and cover requirements is lacking. It is important to learn as much as possible about the remaining populations in Sonora in order to optimize the recovery efforts currently in process.
- 3.61 **Identify seasonal habitat requirements.** An in-depth study of habitat requirements of masked bobwhites in Sonora is needed to develop appropriate management strategies. Information derived from these studies will provide management direction.

- 3.611 Habitat model. Develop a habitat model for use in Mexico and the United States for masked bobwhite recovery.
 - 3.612 Conduct home range studies. Determine home range requirements of masked bobwhites in Sonoran habitats.
 - 3.613 Measure effects of habitat management. Implement and evaluate various habitat management techniques in Sonora.
 - 3.614 Comparative habitat analysis. Compare habitats used by masked bobwhites in Mexico and the United States.
- 3.62 Food habits. Identify seasonal food habits of masked bobwhites in Sonora. Collect and analyze droppings left at roost sites to identify food preferences. Implement other food habits analyses as needed.
4. Public relations. Coordinate with Mexico in developing information and education programs designed to gain public support for the protection and restoration of the masked bobwhite.
- 4.1 Education. Support institutions like Centro Ecologico de Sonora in the development and implementation of public educational programs that describe the plight of the masked bobwhite. Such actions are fundamental to the recovery of this and other endangered species in Mexico. Publication of educational materials in Spanish and English would be of great benefit to those who may affect the recovery of masked bobwhite in Mexico and the United States.
5. Cooperative partnerships. The future of the masked bobwhite depends largely on continued efforts to study and monitor the native populations in Sonora, Mexico.

Partnership programs and cooperative relations with government institutions and ranchers in Sonora are crucial to the survival of the subspecies. A concerted effort should be made to seek out partnership opportunities with the Mexican Government and private landowners. The concept of diversification is of great interest to ranchers in Sonora. Wildlife resources are now being considered as potential sources of income. Therefore, wildlife management is meaningful to private landowners. Positive change on behalf of the masked bobwhite within the core of its historic range must be encouraged.

- 5.1 Provide technical assistance. The USFWS role in an international partnership program would be to provide technical assistance to cooperators. A close working relationship has developed with key individuals and institutions in Sonora. Technical assistance is the cornerstone of a successful working relationship with Mexico.
- 5.2 Support research. The USFWS can enhance this program by supporting research and cooperative agreements that promote recovery of the masked bobwhite in Sonora. Active habitat management should be encouraged and where possible, cooperatively funded. Funding assistance for graduate research should be pursued as appropriate with interested academic institutions.
6. Publication costs. Sufficient funds should be made available for disseminating research results of the recovery effort to the scientific community.
7. Establish and maintain media relationships. An aggressive effort should be made to forge positive working relationships with the media in an effort to publicize the plight of the masked bobwhite. The media should be periodically informed about specific recovery efforts, and research results, as well as, the time-specific demographic status of masked bobwhite populations in both Sonora and Arizona. Media representatives should be kept informed in the United States and Mexico. Production of a masked bobwhite video outlining the current status of the masked bobwhite, the species life history and ecology, as

well as historical events and land management practices that engendered listing as an endangered species, would be an excellent media management and educational tool.

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III. IMPLEMENTATION SCHEDULE

The Implementation Schedule outlines actions and estimated costs for recovery. It is a guide for meeting the objectives discussed in Part II of this plan. This schedule indicates task priority, number, description, duration, responsible agencies, and estimated costs. These actions should bring about the recovery of the species and protect its habitat. Estimated monetary needs for all parties are identified. Part III reflects the total estimated financial requirements for recovery of this species through the year 2003.

Task Priority

Tasks in the Implementation Schedule are arranged in priority order. Priorities are assigned using the following guidelines:

Priority 1.

An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2.

An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.

Priority 3.

All other actions necessary to meet the recovery objectives.

Key to Acronyms Used

USFWS - Wildlife Refuge	(WR)	USFWS - Endangered Species	(SE)
University	(UN)	Centro Ecologico de Sonora	(CES)
Arizona Game & Fish Department	(AGF)	USFWS-Public Affairs	(PA)
Private Industry	(PI)		

III. Recovery Plan Implementation Schedule

Priority #	Task #	Description	Yrs.	Responsible Party			Cost Estimates			Comments
				Region	Program	Other	Yr 1	Yr 2	Yr 3	
1	1.1	Captive Population: Maintain one captive population as a gene pool.	On-going	2	WR		10	10	10	The NBS has indicated that they will not house and care for captive population beyond FY 94. Therefore, PAT is not included as a responsible party.
1	1.2	CAPTIVE POPULATION: Maintain one captive population as a release source.	On-going	2	WR SE		40 10	40 10	40 10	Proposed for housing on BANWR.
1	1.3	GENETIC MANAGEMENT: Maintain and enhance gene pool.	On-going	2	WR		20	20	20	Holding facility has not been chosen.
1	1.4	CAPTIVE POPULATION: Construct a new propagation facility.	1	2	WR		800	--	--	Contingent on receiving special congressional add-on appropriations.
1	2.11	REINTRODUCTION: Release masked bobwhite chicks	On-going	2	WR SE		85 15	100 25	115 35	
1	2.13	MONITOR RELEASE POPULATIONS: Monitor released birds	On-going	2	WR SE		7 3	7 3	7 3	
1	2.21	POPULATION MGMT: Conduct population viability analysis for BANWR	On-going	2	WR	CES UN	5 5 5	5 5 5	5 5 5	
1	2.22	POPULATION MGMT: Minimum viable & effective population site	On-going	2	WR	UN	5 5	5 5	5 5	

III. Recovery Plan Implementation Schedule

Priority #	Task #	Description	Yrs.	Responsible Party			Cost Estimates			Comments
				Region	Program	Other	Yr 1	Yr 2	Yr 3	
1	2.31	HABITAT MGMT: Develop habitat plan for BANWR	On-going	2	WR	CES	5 5	5 5	5 5	
1	2.311	HABITAT MGMT: Discing	On-going	2	WR		75	10	10	
1	2.312	HABITAT MGMT: Food Plots	On-going	2	WR		10	12	13	
1	2.313	HABITAT MGMT: Half-cutting	On-going	2	WR		4	4.5	5	
1	2.314	HABITAT MGMT: Chaining	On-going	2	WR		30	30	30	
1	2.315	HABITAT MGMT: Grazing	On-going	2	WR		30	10	10	
1	2.316	HABITAT MGMT: Fire	On-going	2	WR		200	224	245	
1	2.317	HABITAT MGMT: Water	On-going	2	WR		5	5	5	
1	2.321	HABITAT MGMT: Identify mgmt. alternatives prioritize on cost benefits basis	3 Years	2	WR		2	2	2	

III. Recovery Plan Implementation Schedule

Priority #	Task #	Description	Yrs.	Responsible Party			Cost Estimates			Comments
				Region	Program	Other	Yr 1	Yr 2	Yr 3	
1	2.4	Select preferred mgmt alternative	3	2	WR		2	2	2	
1	2.511	HABITAT INVESTIGATION: Home range studies	3	2	WR	UN	10 10	10 10	10 10	
1	2.512	HABITAT INVESTIGATION: Perform habitat suitability analysis	3	2	WR	UN	10 10	10 10	10 10	
1	2.513	HABITAT INVESTIGATION: determine seasonal habitat requirements	3	2	WR	UN	10 10	10 10	10 10	
1	2.514	HABITAT INVESTIGATION: Effect of habitat mgmt on quail habitat preferences	3	2	WR	UN	10 10	10 10	10 10	
1	2.515	HABITAT INVESTIGATION: Native food plant restoration	3	2	WR	UN AGF PI	10 10 10 10	10 10 10 10	10 10 10 10	
1	2.516	HABITAT INVESTIGATION: Potential competition between quail species	3	2	WR	UN AGF	10 20 10	10 20 10	10 20 10	

III. Recovery Plan Implementation Schedule

Priority #	Task #	Description	Yrs.	Responsible Party			Cost Estimates			Comments
				Region	Program	Other	Yr 1	Yr 2	Yr 3	
1	2.517	HABITAT INVESTIGATION: Habitat model for BANWR	2	2	WR	UN CES	2 2 2	2 2 2		
1	2.521	FOOD HABIT INVESTIGATION: Identify seasonal dietary preferences	3	2	WR	UN	10 10	10 10	10 10	
1	2.531	POPULATION INVESTIGATION: Estimate minimum viable population size	On-going	2	WR	UN	15 10	15 10	15 10	
1	2.532	POPULATION INVESTIGATION: Determine seasonal mortality rates	On-going	2	WR	UN	4 4	4 4	4 4	
1	2.541	RELEASE: Evaluate specific release techniques	3	2	WR SE	UN	10 10 10	10 10 10	10 10 10	
1	2.542	Determine genetic diversity and increase heterozygosity in captive populations	On-going	2	WR	UN	3 3	3 3	3 3	
1	3.11	POPULATION INVESTIGATION: Population monitoring in Sonora	On-going	2	WR	CES	6 6	6 6	6 6	

III. Recovery Plan Implementation Schedule

Priority #	Task #	Description	Yrs.	Responsible Party			Cost Estimates			Comments
				Region	Program	Other	Yr 1	Yr 2	Yr 3	
1	3.12	POPULATION MGMT: Survey potential habitats for new pops. in Sonora	On-going	2	WR	CES	3 3	3 3	3 3	
1	3.2	HABITAT PROTECTION IN SONORA	On-going	2	WR	CES	20 10	20 10	20 10	
1	3.21	MONITOR HABITAT IN MEXICO	On-going	2	WR	CES	10 10	10 10	10 10	
1	3.221	NEW RELEASE SITES: Contact landowners in Sonora	On-going	2	WR	CES	2 2	2 2	2 2	
1	3.222	NEW RELEASE SITES: Conduct habitat suitability analysis	On-going	2	WR	CES	3 3	3 3	3 3	
1	3.23	HABITAT PROTECTION: Establish permanent masked bobwhite refuge	1	2	WR		1500			
1	3.31	COOPERATIVE MGMT PLANS: Cooperative habitat mgmt plans with landowners in Sonora	On-going	2	WR	CES	5 5	15 15	15 15	
1	3.41	MAINTAIN & IMPROVE HABITAT IN MEXICO	On-going	2	WR	CES	3 3	3 3	3 3	
1	3.61	HABITAT INVESTIGATION: Identify seasonal habitat requirements in Mexico	3	2	WR	UN CES	10 10 10	10 10 10	10 10 10	

III. Recovery Plan Implementation Schedule

Priority #	Task #	Description	Yrs.	Responsible Party			Cost Estimates			Comments
				Region	Program	Other	Yr 1	Yr 2	Yr 3	
1	3.62	FOOD HABITS: Conduct food habit studies in Mexico	3	2	WR	UN CES	10 10 10	10 10 10	10 10 10	
1	3.611	HABITAT INVESTIGATION: Habitat model for Mexico	2	2	WR	UN CES	2 2 2	2 2 2		
1	3.612	HABITAT INVESTIGATION: Conduct home range studies in Mexico	2	2	WR	UN CES	10 10 10	10 10 10		
1	3.613	HABITAT INVESTIGATION: Measure effects of habitat mgmt on quail in Mexico	On-going	2	WR	UN CES	10 10 10	10 10 10	10 10 10	
1	3.614	HABITAT INVESTIGATION: Compare Sonora & Arizona habitats	2	2	WR	CES	2 2	2 2		
1	4.1	PUBLIC RELATIONS: Conduct education program in Sonora	On-going	2	WR	CES	5 6	5 6	5 6	
1	5.2	SUPPORT RESEARCH IN MEXICO	On-going	2	WR	CES	10 10	10 10	10 10	

III. Recovery Plan Implementation Schedule

Priority #	Task #	Description	Yrs.	Responsible Party			Cost Estimates			Comments
				Region	Program	Other	Yr 1	Yr 2	Yr 3	
1	5.1	PROVIDE TECHNICAL ASSISTANCE IN MEXICO	On-going	2	WR	CES	2 3	2 3	2 3	
2	3.511	REINTRO: Evaluate potential release sites in Sonora	On-going	2	WR	CES	2 2	2 2	2 2	
2	3.52	REINTRO: Develop a release plan for Sonoran habitats	On-going	2	WR SE	CES	3 3 3	3 3 3	3 3 3	
2	3.13	REINTRO: Select introduction sites in Sonora	On-going	2	WR SE	CES	2 2 2	2 2 2	2 2 2	
2	3.53	REINTRO: Release birds in Sonora	On-going	2	WR SE	CES	4 1 4	4 1 4	4 1 4	
2	3.54	REINTRO: Monitor survival of release in Sonora	On-going	2	WR	UN CES	5 5 5	5 5 5	5 5 5	
3	2.533	POPULATION MGMT: Evaluate various census techniques	1	2	WR	CES UN	10 10 10	10 10 10		

III. Recovery Plan Implementation Schedule

Priority #	Task #	Description	Yrs.	Responsible Party			Cost Estimates			Comments
				Region	Program	Other	Yr 1	Yr 2	Yr 3	
3	6	PUBLICATION COSTS	4	2	WR SE		5 2 3	5 2 3	5 2 3	
3	7	ESTABLISH AND MAINTAIN MEDIA RELATIONSHIPS	On-going	2	WR SE	CES AGF	1 1 1 1	1 1 1 1	1 1 1 1	

IV. APPENDIX COMMENTS

Principal Comments Received on the Masked Bobwhite Technical/Agency Draft Recovery Plan

Thirty individuals or agencies requested copies of the plan for review. Ten responses were received, each containing relevant and helpful remarks. All comments were considered when revising the draft. The authors appreciate the time contributed by each reviewer. Comments discussed below represent a composite of those received. Comments of similar content are combined into general groups. Only critical comments, or those raising questions or suggestions relevant to masked bobwhite recovery, are included in this discussion. Comments were received from the following individuals:

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Comment 1. The plan states that the Altar Valley is historic habitat for masked bobwhites, and that the species was present in the Valley before extirpation approximately 100 years ago. This statement is based on the records of early Naturalists who observed and collected masked bobwhites in the Altar Valley during the late 19th century. These

historical accounts do not prove that the species was endemic to the Valley nor that masked bobwhites ever existed in self-sustainable numbers. Since the Altar Valley is the northern fringe of the species historic range, climatic and habitat conditions were either inappropriate or insufficient to support a self-sustainable population. The historic accounts represent periodic and local observations of masked bobwhites that migrated north from Mexico when climatic and habitat conditions were adequate. It is suggested that masked bobwhites were never permanent residents of the Altar Valley or at the very least, if they were present, small populations existed in fragmented habitats and were possibly temporary.

Service Response. The historical accounts cited in the plan indicate that masked bobwhites were observed or collected throughout the length of the Altar Valley, from the international border up to within a few miles of the Three Points/Robels Junction area. Specimens obtained from the Altar Valley by Mr. Herbert Brown, an early Tucson naturalist, are currently present in the Ornithology Range maintained by the University of Arizona. Additionally, interviews with early settlers indicated that masked bobwhites were commonly observed throughout the Valley and at times, were abundant before cattle grazing became prevalent during the late 19th century. Masked bobwhite abundance, habitat use and their distribution throughout the Altar Valley before the species' extirpation are conjecture and will remain so because these variable were never quantified. This information is also based on the observations of individuals who are now deceased. However, masked bobwhites have recently demonstrated self-sustainability on the Buenos Aires National Wildlife Refuge. A permanent population that has survived from year-to-

year, and accomplishes natural reproduction on an annual basis, currently exists on the Refuge. Present habitat conditions are different than were evident during the beginning of the 20th century, yet the current masked bobwhite population appears capable of maintaining low density levels. Recent research has indicated that masked bobwhites are rather sedentary. Movements of several miles have been documented, though most individuals rarely move more than a mile from a release site or an established home range. Long-distance movements like those demonstrated by true migratory species are improbable. It is unlikely that masked bobwhites migrated from Mexico up the length of the Altar Valley during years when environmental and habitat conditions were favorable for quail utilization. The USFWS is therefore of the opinion that a permanent, self-sustaining masked bobwhite population did once exist in the Altar Valley.

Comment 2. Attributing the extirpation of masked bobwhites in Arizona to cattle grazing is questionable. Cattle and wildlife can co-exist successfully, and did so on the Buenos Aires Ranch before the property was purchased by the USFWS. The ranch was well managed and not over-grazed yet previous masked bobwhite releases were unsuccessful. These early failures cannot be attributed to cattle grazing.

Service Response. While it is certainly true that cattle and wildlife can co-exist successfully, one cannot overgeneralize because certain wildlife species are very sensitive to grazing pressure, and most species do not tolerate overgrazing well. The masked bobwhite must have lush, diverse, native herbaceous cover in suitable quantities to survive and persist as a viable population. Numerous historical accounts indicate that most of the

Altar Valley was overgrazed a century ago. The present plant community, as well as several aspects of the Refuge's topography, indicate that the Refuge was once overgrazed. USFWS Biologists do not believe that this severe overgrazing and the extirpation of the masked bobwhite from the Altar Valley was coincidental. The species simply could not tolerate the cattle-induced habitat loss that transpired a century ago. This fact remains evident in Sonora, Mexico, today where masked bobwhites still inhabit ranches subjected to cattle grazing. The birds restrict their use of habitats to areas that are either protected from grazing, sites where forage is difficult for cattle to obtain due to natural impediments, or pastures that are managed in a manner that preserves sufficient native herbaceous cover. The BANWR was purchased and established in order to provide masked bobwhites with undisturbed habitat. Early masked bobwhite researchers attributed unsuccessful attempts to restore the species to the Altar Valley to their inability to regulate grazing pressure on release sites. An ungrazed area of sufficient size to support a viable masked bobwhite population was considered essential to the recovery effort. The USFWS is thus of the opinion that the Altar Valley, including the site of the present Refuge, was overgrazed and that overgrazing and masked bobwhite recovery are incompatible.

Comment 3. Habitat management to improve masked bobwhite survival is questionable. If, after almost 10 years, the recovery program has not been successful, how can the implementation of habitat improvements be expected to enhance the recovery program?

Masked bobwhite will probably never survive on the BANWR because the climate is unsuitable for population re-establishment.

Service Response. Habitat management has been used to improve bobwhite habitat on a diversity of areas throughout the U.S.. There exists a long history of successful bobwhite habitat management programs. The habitat management techniques mentioned in the Recovery Plan have been used on South Texas rangelands, which are very similar to those present on the BANWR, to create, restore or improve essential habitat elements that were otherwise lacking. Because the BANWR is so similar to South Texas range lands, there is reason to believe that some of the habitat management techniques that stimulate bobwhite population increases in Texas will also stimulate a masked bobwhite population increase on the BANWR. As mentioned in an earlier response, there is little doubt that masked bobwhites once inhabited the Altar Valley. It is the Service's opinion that local weather did not seriously limit population viability so long as habitat remained suitable. Over the past century, overgrazing and the introduction of exotic vegetation have changed the landscape in a manner that currently precludes masked bobwhite survival. Restoration of the native savanna grassland is essential to the masked bobwhite recovery effort. In fact, the Service has a legal mandate to manage habitat in a manner that is beneficial to the endangered masked bobwhite. Removing livestock from the BANWR has achieved this to a certain extent as native perennial grasses are becoming more abundant. However, additional habitat management measures are necessary to expedite restoration of the native vegetation thereby not only improving habitat for masked bobwhites but also improving habitats for other wildlife species indigenous to the Refuge.

Comment 4. Disking is a destructive practice. It will increase the threat of erosion and stimulate the growth of undesirable vegetation. This practice will not help the BANWR masked bobwhite population.

Service Response. Disking is a practice that has been used successfully on South Texas range lands to increase bobwhite food supplies and woody plant invasions. Range disking is currently being utilized in Sonora, Mexico to improve large acreages of masked bobwhite habitat. Marked habitat improvement is evident and masked bobwhites have been observed utilizing disked acreages within a year of disturbance. Native forbs and perennial grasses have germinated on areas that were once dominated by catclaw acacia and mesquite despite 3 years of drought. Disking could yield similar results on the BANWR. It is possible that species such as Russian thistle may appear shortly after a disking operation. However native perennial grasses will eventually appear over several years because the original native seed bank remains intact and viable. Disking should improve masked bobwhite foods, by increasing native forb abundance. Mesquite suppression will also improve masked bobwhite habitat. Erosion will not be a threat because disking will be applied in narrow meandering strips. It is the Service's opinion that range disking will suppress exotic plants, suppress woody vegetation and set back plant succession to the pioneer stage where native perennial herbaceous vegetation will eventually dominate the strips thus improving the habitat for masked bobwhites.

Comment 5. Chaining is not consistent with masked bobwhite recovery. Chaining was conducted on hundreds of acres when the BANWR was the Buenos Aires Ranch and this resulted in improved habitat for Gambel's quail to the detriment of the masked bobwhite population.

Service Response. Like discing, chaining has been used successfully on South Texas range lands to stimulate bobwhite density increases via habitat improvement. Chaining has also been utilized in Sonora, Mexico to improve masked bobwhite habitat and the birds have responded positively. Chaining typically clears treated areas of mesquite and other invading woody vegetation permitting herbaceous vegetation an opportunity to flourish. Over 1000 acres were chained by the owners of the Buenos Aires Ranch before the Refuge was established. The USFWS has not however conducted chaining operations though chaining would be considered a technique that is consistent with the Service's goal of simultaneously restoring the native plant community and establishing a viable masked bobwhite population on the BANWR. Additionally, chaining operations are largely detrimental to Gambel's quail, at least initially and for several years after an operation, because this species typically occurs in brushy habitats. Removing a significant portion of the woody component would cause most Gambel's quail to leave treated areas in favor of habitats with greater shrub density and cover. Chaining would likely have improved habitat conditions for masked bobwhites, though there is no indication that the birds were ever released or otherwise present on the areas that ranch owners chained. It is the Service's opinion that chaining would benefit masked bobwhites and it therefore remains a habitat management alternative in the Recovery Plan.

Comment 6. Prescribed burning is a questionable management technique. It cannot be conducted during an optimum time of the year because ideal burning conditions are unpredictable. Because burning cannot be conducted during an optimum time, coupled with the abundance of dry grass on the Refuge, prescribed fire is very dangerous and may someday cause a “holocaust”.

Service Response. The BANWR prescribed burning program was initiated in 1988 and prescribed fires have been ignited safely each year since. A fire management plan is developed annually, and one of the plan’s objectives is to manage fine fuels in an effort to minimize the threat of wildfire. The Refuge Manager attempts to conduct prescribed burns on 14,000-to-20,000 acres annually. Since the USFWS is a Federal agency, prescribed burning is strictly regulated and burning policy is rigidly enforced. Prescribed fires can only be ignited under very specific environmental conditions and fires have, and never will be ignited, unless appropriate structural fire controls are in place and the necessary equipment and personnel are available. Additionally, the Refuge Fire Management Officer and his Fire Crew must successfully finish numerous training classes as well as meet rigorous physical fitness requirements before they can participate in a prescribed burn. Safety is the top priority for every member of the BANWR Fire Crew. A prescribed fire has never escaped the boundaries of the Refuge and a member of the Fire Crew has never been seriously injured. The BANWR is also an active member of the Southeastern Arizona Fire Management Zone and therefore has numerous sister agency

fire support personnel on call should they ever need assistance for a Refuge fire. The Refuge fire crew operates under a mandate to control all wildfires that ignite on the BANWR and often assist in the suppression of wildfires that are ignited on neighboring private and federally-owned property. A fire, be it a prescribed burn or a wildfire, is always a potentially dangerous situation. However, the BANWR fire crew is highly trained in fire containment and suppression. They have safely and successfully conducted every prescribed burn ignited on the Refuge since the program's inception. With regard to masked bobwhite recovery, prescribed burning has been used successfully for decades to improve bobwhite habitat throughout the species range in North America. BANWR Biologists have observed increased masked bobwhite use of burn units as a result of the habitat alterations achieved by prescribed burning. The BANWR prescribed burning program also suppresses subshrub and shrub invasions on Refuge grasslands. It is therefore the Service's opinion that the use of prescribed fire is consistent with Refuge policy and goals.

Comment 7. The sprinkler system mentioned in the Recovery Plan is an unnecessary waste of taxpayer dollars. Using a sprinkler system to improve masked bobwhite habitat conditions is artificial and indicates that USFWS Biologists do not believe masked bobwhite population viability can be achieved under natural conditions.

Service Response. Rainfall is essential to masked bobwhite ecology, and therefore the species recovery on the BANWR. Drought is common throughout southeastern Arizona. When dry conditions prevail, nesting cover, brood habitat and food supplies are generally

limited. Chick production also declines because masked bobwhites require humidity levels in excess of 90 percent during their breeding season in order for reproductive activity to occur. Masked bobwhite populations therefore decrease significantly as a result of drought. While it is true that drought was a condition that confronted the original Altar Valley masked bobwhite population a century ago, the population sustained itself, albeit at low densities, until rainfall resumed and habitat conditions improved. The habitat alterations that occurred due to overgrazing and the introduction of exotic vegetation make the re-establishment of viable masked bobwhite population difficult. Habitat rehabilitation is essential, however this requires years and is exacerbated by drought. The use of a sprinkler system would mitigate the effects of drought and expedite the vegetative rehabilitation process thus expediting population recovery. However, it is unlikely a sprinkler system would ever be utilized due to concerns about the expense involved.

Comment 8. Masked bobwhite research should have been accomplished years ago when the BANWR was first established. Investing additional money in research will not enhance recovery efforts at this time. Masked bobwhite research in Mexico is a waste of taxpayer's money. It will not help the recovery effort on the BANWR.

Service Response. Research is essential to masked bobwhite recovery. Wildlife biologists initiated research efforts soon after the Refuge was established. One Master of Science thesis and several technical papers were produced as a result of these efforts. During the past 2 yrs the research effort has increased. Currently three graduate students are studying various aspects of masked bobwhite ecology on both the BANWR and

Mexico. Refuge Biologists are also pursuing additional projects on the Refuge. Though the USFWS is funding the majority of the work, these studies are a cooperative effort. The Arizona Game and Fish Department provided \$45,000 for research on the BANWR and Texas A&M University-Kingsville and the University of Arizona are supporting other aspects of the research effort. The work being conducted is vital to masked bobwhite recovery. The Sonoran birds represent the only remaining native wild population of birds known to exist at this time. It is imperative that we learn as much as possible about these wild birds in order to ensure that the viability of this wild gene pool is maintained. Information derived from the study being conducted in Sonora will not only preserve the last known native wild population but will aid recovery efforts on the BANWR. Though research results are preliminary, the information gathered thus far is encouraging. The habitat work has revealed that native herbaceous vegetation is critical to the maintenance of viable masked bobwhite populations. This information confirms earlier assertions that overgrazing is detrimental to masked bobwhite populations. Adequate herbaceous cover and diversity must be maintained for the species to persist from year to year. Demographic studies have yielded annual density estimates for the first time. Knowledge of masked bobwhite densities is essential in order to determine how masked bobwhites respond to changes in their environment. The USFWS and their cooperators in Sonora plan to translocate wild birds from Mexico to the BANWR. Translocation will only be possible after it is determined that a surplus of birds exists in Sonora. Annual density estimates will provide this information and eventually permit masked bobwhite

translocation to Arizona. Therefore, it is the Service's opinion that the research effort is necessary for masked bobwhite recovery to succeed.

Comment 9. The Recovery Plan indicates that the Santa Cruz Valley is historic masked bobwhite habitat and that the USFWS intends to buy property in this area for another Refuge. This is objectionable because restoration of a viable masked bobwhite population in this area would not succeed if it has been unsuccessful on the BANWR.

Service Response. According to historic accounts the Santa Cruz Valley once did harbor masked bobwhites. However, there is no mention in the Recovery Plan of a proposal to purchase property in the Santa Cruz Valley as a site for future masked bobwhite reintroduction. Rather the Recovery Plan states that a second population of masked bobwhites should be established after a viable population has been established on the BANWR. The Santa Cruz Valley was identified as historic habitat only. The USFWS does not currently plan to establish a second permanent masked bobwhite Refuge anywhere along the Santa Cruz river drainage.

Comment 10. After 10 yrs of effort the USFWS has failed in its efforts to re-establish a self-sustainable population of masked bobwhites on the BANWR. Any future management actions on the part of the USFWS will have as great an impact on the land as ranching or any other human use. Therefore the BANWR should be dissolved as a National Wildlife Refuge and sold to interested members of the private sector. Another alternative would be for the USFWS to maintain 2000 acres for masked bobwhites and

allow area ranchers to purchase the remaining acreage for cattle grazing. These ranchers could cooperate with the USFWS in restoring a viable masked white population to the Altar Valley. Future efforts to maintain the BANWR as a site for masked bobwhite reintroduction will be a waste of taxpayer's money.

Service Response. The primary reason the USFWS purchased the Buenos Aires Ranch was to preserve a large tract of Sonora savanna grassland for the re-establishment of a viable masked bobwhite population. The BANWR currently represents one of the largest contiguous tracts of grassland remaining in Arizona. As stewards, the USFWS can now protect this remnant savanna, and its unique flora and fauna, for the public's enjoyment for perpetuity. In addition to the masked bobwhite, 2 other endangered species and one threatened species are currently protected on the BANWR. The ecosystem that comprises the Refuge is an important part of the U.S. public's natural heritage where human disturbance is minimized. Thousands of visitors from all over the U.S. visit the BANWR annually, not just for the opportunity of seeing a masked bobwhite, but to enjoy the natural beauty of the area as well. The only way the Refuge property can be disposed of is through Congressional Action. The Buenos Aires National Wildlife Refuge is strongly supported by members of Congress.