Masked Bobwhite
(Colinus virginianus ridgwayi)

5-Year Review:
Summary and Evaluation

Photograph by Paul Zimmerman

U.S. Fish and Wildlife Service
Buenos Aires National Wildlife Refuge
Sasabe, AZ
March 2014

5-YEAR REVIEW

Masked Bobwhite (*Colinus virginianus ridgwayi*)

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office Southwest Region, Region 2, Albuquerque, NM
Susan Jacobsen, Chief, Division of Classification and Restoration, 505-248-6641
Wendy Brown, Chief, Branch of Recovery and Restoration, 505-248-6664
Jennifer Smith-Castro, Recovery Biologist, 505-248-6663

Lead Field Office: Buenos Aires National Wildlife Refuge (BANWR)
Sally Gall, Refuge Manager, 520-823-4251 x 102
Juliette Fernandez, Assistant Refuge Manager, 520-823-4251 x 103
Dan Cohan, Wildlife Biologist, 520-823-4351 x 105
Mary Hunnicutt, Wildlife Biologist, 520-823-4251

Cooperating Field Office(s): Arizona Ecological Services Tucson Field Office
Jean Calhoun, Assistant Field Supervisor, 520-670-6150 x 223
Mima Falk, Senior Listing Biologist, 520-670-6150 x 225
Scott Richardson, Supervisory Fish and Wildlife Biologist, 520-670-6150 x 242
Mark Crites, Fish and Wildlife Biologist, 520-670-6150 x 229

Arizona Ecological Services Field Office
Steve Spangle, Field Supervisor, 602-242-0210 x 244

1.2 Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service or USFWS) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing as endangered or threatened is based on the species' status considering the five threat factors described in section 4(a)(1) of the Act. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process including public review and comment.

1.3 Methodology used to complete the review:

This review was completed by Buenos Aires National Wildlife Refuge (BANWR), Sasabe, Arizona. In addition to the general solicitation of public comments published in the Federal Register (74 FR 6917), comments were solicited from individuals and organizations familiar with or responsible for the species. From this targeted solicitation, three letters or emails were received from Mexican sources which commented on the status of the bird, but which provided no new information (see Experts Consulted). This 5-year review was completed using the best information which has become available since the publication of the most recent Masked Bobwhite Recovery Plan (USFWS 1995). Information used came from published literature, informal documents, unpublished data, verbal correspondence with subject experts, recovery team discussions, research results, refuge files and the personal experience of BANWR staff.

1.4 Background:

1.4.1 FR Notice citation announcing initiation of this review: 74 FR 6917

1.4.2 Listing history

Original Listing
FR notice: 32 FR 4001
Date listed: March 11, 1967
Entity listed: *Colinus virginianus ridgwayi*
Classification: Endangered

1.4.3 Associated rulemakings: None

1.4.4 Review History: This is the first review for this subspecies since the 1995 recovery plan was published.

1.4.5 Species' Recovery Priority Number at start of 5-year review: At the start of the 5-year review, the Recovery Priority Number for the masked bobwhite was 6. This number indicates that: (1) the masked bobwhite was listed as a subspecies; (2) populations face a high degree of threat; (3) recovery potential is low; and (4) recovery of the masked bobwhite is not likely to be in conflict with construction or other development projects (see Table 1).

Table 1. The below ranking system for determining Recovery Priority Numbers was established in 1983 (48 FR 43098, September 21, 1983 as corrected in 48 FR 51985, November 15, 1983).

Degree of Threat	Recovery Potential	Taxonomy	Priority	Conflict
High	High	Monotypic Genus	1	1C
		Species	2	2C
		Subspecies/DPS	3	3C
	Low	Monotypic Genus	4	4C
		Species	5	5C
		Subspecies/DPS	**6**	6C
Moderate	High	Monotypic Genus	7	7C
		Species	8	8C
		Subspecies/DPS	9	9C
	Low	Monotypic Genus	10	10C
		Species	11	11C
		Subspecies/DPS	12	12C
Low	High	Monotypic Genus	13	13C
		Species	14	14C
		Subspecies/DPS	15	15C
	Low	Monotypic Genus	16	16C
		Species	17	17C
		Subspecies/DPS	18	18C

1.4.6 Recovery Plan or Outline

Name of plan or outline: Masked Bobwhite Recovery Plan
Date issued: April 1995
Dates of previous revisions, if applicable: 1978, 1984

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

2.1.1 Is the species under review a vertebrate? Yes

2.1.2 Is the species under review listed as a DPS? No

2.1.4 Is there relevant new information for this species regarding the application of the DPS policy? No

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan? Yes

2.2.1.1 Does the recovery plan contain objective, measurable criteria? Yes

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat? No.

The recovery plan was last revised in 1995. Recovery criteria were described, but may not reflect the status or biology of the masked bobwhite as we know it today. At the time of the writing of the last revision of the plan, few quantitative studies were available regarding masked bobwhite life history and habitat needs. A Recovery Team was formed in 2008 to provide input on immediate measures that would address the dire status of the masked bobwhite. If the status of the masked bobwhite improves to the point that emergency measures are no longer needed, the Recovery Team may be tasked with updating and revising the Recovery Plan based on the current status and extent of knowledge related to the masked bobwhite.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

The recovery criteria section of the 1995 Recovery Plan states "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 of the species are not known at this time. The earliest estimated date for downlisting is 2007." (USFWS 1995).

A recovery objective was described at length prior to the criteria statement. This objective clarified that primary recovery in Arizona is to establish and maintain a viable self-sustaining population of at least 500 birds on BANWR. If available, a second site would be selected and actions taken to establish a population, but priority would be given to the work on BANWR. Within Mexico, emphasis would be on preserving the remaining populations and restoring them to optimum population levels sustainable by available habitat.

While the criteria for down-listing, as stated in the Recovery Plan, is somewhat measurable (2 populations in the U.S. and 2 populations in Sonora sustained for 10 years), the population size goal is not based on masked bobwhite biology, but rather on the biology of other subspecies of northern bobwhites in the southeastern United States (Rosene 1969). The Plan states that "it is sufficient to use the 1984 figure of 200 calling males as an interim population objective until better information is available" because "a population containing 200 calling males probably consists of about 500 adult birds at the onset of the breeding season, around July 1." In fact, Gee expressed doubt in 1993 (USFWS 1995) that 500 individuals of an r-selected species (a small-bodied, short-lived species with high fecundity) adequately represent self-sustainability. The Masked Bobwhite Population and Habitat Viability Assessment (USFWS 1996) predicted

extinction within 20 years given a population size of 500. No criteria were developed for delisting the masked bobwhite.

Surveys since 2001 have shown an overall downward trend in populations both in the United States and in Mexico (Tables 2 and 3). With the only known wild Mexico population approaching zero, and the sole United States population of reintroduced birds also approaching zero birds, the recovery criteria have not been met.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

The latest revision to the Recovery Plan (USFWS 1995) presented a thorough summary of available information to that point in time. Information presented below will reflect updated information from 1995-2011, much of which has been summarized in Hernandez et al. (2006).

2.3.1.1 New information on the species' biology and life history:

Reproduction: Hernandez et al. (2006) discussed the differences between reproduction in masked bobwhites and other subspecies. As a bird that is adapted to a semi-arid environment characterized by pronounced precipitation peaks in late summer, the masked bobwhite initiates breeding much later in the year and experiences a much shorter breeding season than its eastern counterparts. In masked bobwhites, breeding typically commences in June and the season lasts only about 90 days, corresponding to the monsoonal rains. Eastern subspecies initiate breeding in March and have approximately 120 days to complete the breeding season. Northern bobwhites, in general, require 47-55 days to lay and incubate their first clutch, and require 20-34 days between clutches (Burger et al. 1995). Mathematically speaking, re-nest attempts by masked bobwhite following nest destruction or abandonment are not likely due to the short duration of monsoon. This significantly reduces the reproductive potential and associated productivity of masked bobwhite as compared to other bobwhite subspecies.

Effects of temperature and moisture: Camou et al. (1998) found that masked bobwhite populations increased in 11 of 13 years when mean summer precipitation was >20 cm (7.9 in.), but declined in 13 of 14 years when mean summer precipitation was <20 cm. High temperatures in combination with dry atmospheric conditions may reduce the amount of thermally suitable habitat (Guthery et al. 2001c) as heat reduces the proportion of bobwhite hens that lay eggs and the proportion of males that produce sperm.

Casual observations by BANWR staff of mortalities of captive masked bobwhites held in outdoor pens with varying degrees of cover seem to indicate that there may be a lowered tolerance for extreme cold temperatures. When night-time temperatures drop into the 10 to 20 degree Fahrenheit (F) range (-12 to -7 degree

Celsius (C)), or when cold and rainy conditions occur together, birds are sometimes found dead in roost rings. It is not known how this might affect truly wild birds, since the captive birds had limited choices for seeking cover, and wild birds may be able to move out of colder areas into better roost sites.

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

Captive Flock: Recent survey results, in both the U.S. (BANWR) and Mexico, indicated that occurrence of wild masked bobwhite is essentially non-existent. As of 2011, occurrence of the masked bobwhite is nearly completely restricted to the captive flock occurring on the BANWR. Approximately 600-1000 birds are held at any one time on BANWR, with approximately 50-70 individuals kept at Northern Illinois University for genetic research. Additional individuals (1-12 birds each) are at various zoological institutions around the country. Numbers of captive birds vary widely from year to year, as well as within single years, due to annual variability in hatching of chicks and mortality rates in both juvenile and adult birds.

An additional captive breeding facility has been completed at Africam Safari in Puebla, Mexico. CITES and other pertinent permits are currently in place for this state-of-the-art facility to acquire at least 50 breeding pairs from BANWR. The plans are for this new facility to produce birds for release on Mexican ranches. Initial transfer of birds should be complete in 2014.

Wild Populations (BANWR): Intensive surveys of various types (breeding season call-count surveys, fall-winter assembly call surveys, line transects) have taken place on BANWR since the establishment of the refuge and the implementation of a release program.

The longest-running survey and the only type being done at the present time on the refuge is the breeding season survey of calling males. Masked bobwhites are notoriously difficult to detect and accurately count on these call-count surveys, and it is even more difficult to translate calling males to total numbers of bobwhites. Several factors are responsible for this. They do not call until micro-site temperature and humidity are appropriate, bouts of calling are frequently short in duration, multiple males may be calling from adjacent perches and are counted as one, unpaired males are more likely to call than paired males, and males do not call every day during breeding season. In fact, some bobwhite males may only call for a few days each season and may cease calling once paired. With the large area needing coverage (BANWR and surrounding area), staff numbers are not adequate to cover the landscape and detect all of these extremely rare and elusive birds.

For several years, a small, but somewhat stable, number of calling males were detected annually on formal summer call-count surveys. From 2006-2009 releases were suspended to test the theory that the available habitat might have been saturated, though the numbers were small, and to see if the population was self-sustaining. This experiment was ill-timed, and the winters of 2005-6 and 2006-7 were some of the driest on record. The numbers detected on formal surveys were zero for three straight years (2006-2009) following the onset of these drought conditions. However incidental encounters were made during this same time period, with 5-9 birds being seen or heard each year, although not as part of any official surveys. Following a small release of 74 individuals in 2010, 4 birds were detected during formal surveys, but single individuals or small groups were heard in the vicinity of the release sites for a few months following release. Numbers of birds detected on formal call-count surveys during 13 years of uniform survey effort on BANWR are listed in Table 2.

Because of the bird's scarcity, casual observations by refuge visitors, volunteers, and staff are recorded, and refuge biologists attempt to confirm these. Sometimes these are cases of mistaken identity, and sometimes the sightings are successfully confirmed as masked bobwhite. Each year since 2006, fewer than 10 confirmed sightings or aural detections of masked bobwhite occurred. One particularly interesting sighting occurred on November 17, 2009, when at least 2 masked bobwhite (a male and female) were seen with a covey of 8-10 Montezuma's quail (*Cyrtonyx montezumae*) in lower elevation foothills on the east side of the Refuge.

Table 2. Number of calling males detected on BANWR survey routes 1999-2011. * indicates minimal effort expended on surveys. No birds were released on BANWR from 2006-2009

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
#Males	48	2 *	29	20	12	26	20	6	0	0	0	4	1

Wild Populations (Mexico): In Mexico, the core of the masked bobwhite range (roughly 15 miles (24 km) south of Benjamin Hill, Sonora) has been surveyed regularly since 1968 (Table 3). These surveys were done on Rancho El Carrizo, Rancho San Dario, and Rancho Los Cuervos (all adjacent to each other), and Rancho Grande roughly 20 mi (32 km) south of El Carrizo, and Rancho El Arpa west of Rancho Grande. An attempt was made to survey the same routes each year; however, denial of entry, locked gates, inability to contact landowners, impassable roads, and changes to the road system have made it difficult or impossible to standardize routes. As Rancho Grande became a near mono-culture of buffelgrass *(Pennisetum ciliare)*, bird numbers diminished and surveys were reduced or suspended. Bobwhites disappeared from Rancho El Arpa in the early 1990s and surveys were suspended there at that time, as well. In addition, between

2002 and 2006, the lack of grass cover along many of the routes caused surveyors to look elsewhere within the survey areas, because, in our experience, zero cover translates into zero birds.

Table 3. Surveys done on Mexican ranches in the Benjamin Hill, Sonora, area from 1968-2011. Methods varied but primarily involved line transects and point counts ("-" indicates no data collected that year).

Year	El Carrizo/San Dario/Los Cuervos	Grande	El Arpa
1968	35	-	-
1969	32	34	-
1970	44	36	-
1971	32	27	-
1972	12	32	-
1973	13	-	-
1974	4	17	-
1975	-	15	-
1976	1	9	-
1977	0	3	-
1978	3	7	-
1979	0	20	-
1980	4	12	-
1981	1	21	-
1982	-	12	-
1983	0	37	-
1984	-	-	-
1985	41	45	7
1986	-	-	-
1987	53	7	3
1988	22	2	0
1989	20	0	-
1990	36	12	12
1991	55	1	2
1992	-	-	-
1993	54	0	0
1994	26	0	0
1995	27	0	0
1996	14	10	0
1997	2	0	0
1998	72	2	0
1999	-	-	-
2000	-	-	-
2001	19	-	-
2002	3	-	-
2003	2	0	-
2004	2	0	-
2005	0	0	-
2006	0	0	-
2007	5 or 6	-	-
2008	3	0	-
2009	0	0	-
2010	0	-	-
2011	2	-	-

Intensive surveys focused on the El Carrizo-San Dario-Los Cuervos area from 2007-2011. These involved numerous biologists and volunteers from the U.S. and Mexico. These surveys involved both call count surveys and intensive walking searches of appropriate habitat during breeding season and surveys of good fall/winter habitat using bird dogs. Very few detections were made, and no masked bobwhite were detected in 2009 or 2010. However, in 2011 a ranch hand on Rancho San Dario reported hearing 2 female bobwhites (E. Gomez pers. com.), which is encouraging.

In addition, portions of central and eastern Sonora, Mexico, have recently been surveyed from the air to try to detect potential masked bobwhite habitat (Brown et al. 2012). Intensive ground surveys were then conducted in areas that appeared to be suitable habitat from the air in order to document potential areas in which to conduct more detailed masked bobwhite surveys. Landowners and ranch personnel are being questioned as to the presence of the masked bobwhite on their lands. Thus far, these efforts have been unproductive. It appears that the masked

bobwhite is dangerously close to extinction in the wild in both Mexico and the U.S.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

Genetics of Captive vs. Wild Birds: A study done by DeYoung et al. (2005) compared genetic material from the captive flock (which originated from Sonoran Mexican stock captured in the 1960s, 70s and 80s) held at BANWR, a population of wild birds caught in 2004 on BANWR, and wild Sonoran birds which had been translocated to the refuge in 1999 in the vicinity of the wild refuge population. Using microsatellite DNA they determined that the wild refuge birds were of mixed ancestry, consisting of 72% captive and 28% Sonoran stock. Considering that captive birds also were released from 1999-2004, the presence of Sonora ancestry at BANWR several generations after a single release suggests that wild Masked bobwhites and their descendants were more successful than captive-reared birds. This implies greater survivorship and/or greater reproductive success amongst translocated bobwhites than the captive-reared individuals released at BANWR. Three mtDNA haplotypes were found in the masked bobwhites studied, two each in the captive flock and the Sonora sample, and all 3 in the wild BANWR sample.

Genetic Diversity: DeYoung (2005) compared the genetic diversity of the wild Sonoran birds and the BANWR birds with that of Texas bobwhites. On a scale of 0 to1 where 1 represents the highest possible genetic diversity, gene diversity was qualitatively highest in the Texas birds (0.72), followed by Sonoran birds (0.60), the captive bobwhites (0.53), and the wild BANWR birds (0.53). Sonoran birds maintained relatively high gene diversity at neutral nuclear loci despite a population reduction. But wild bobwhite samples from Sonora and BANWR deviated from mutation-drift equilibrium, indicating a recent genetic bottleneck or founder event. In addition, genetic similarity was greatest between Texas and Sonoran birds.

DNA-Based Pedigree: In 2006-2007, a pedigree was constructed for the captive masked bobwhites at BANWR by using feather DNA. At the time there were approximately 600 birds held in captivity at BANWR, but due to costs of analyses, only 218 birds were used to develop the pedigree. These became the new founders for the population and the source populations for all future breedings. A subsequent die-off at the captive facility removed 41 of these new founders in June and July 2007 (BANWR unpublished data). These reductions in breeding stock may be another source of genetic bottlenecking in addition to the initial population declines in the wild, which may lead to reduced genetic diversity within the captive flock.

2.3.1.4 Taxonomic classification or changes in nomenclature:

Distinct Subspecies: While most quail taxonomists recognize 21 or 22 subspecies of northern bobwhite (Guthery 2000), there is confusion about the delineation of these subspecies (Brennan 1999).

Comparing genetic variability of northern bobwhites (which includes the masked bobwhite subspecies) across their range using mitochondrial and nuclear microsatellite loci, Eo (2008) found that compared with 6 other subspecies, masked bobwhite exhibited low genetic diversity and were extremely differentiated from the other subspecies and populations studied. Eo (2008) confirmed that the masked bobwhite is a distinct subspecies and it is important to manage it as a distinct unit for conservation and management.

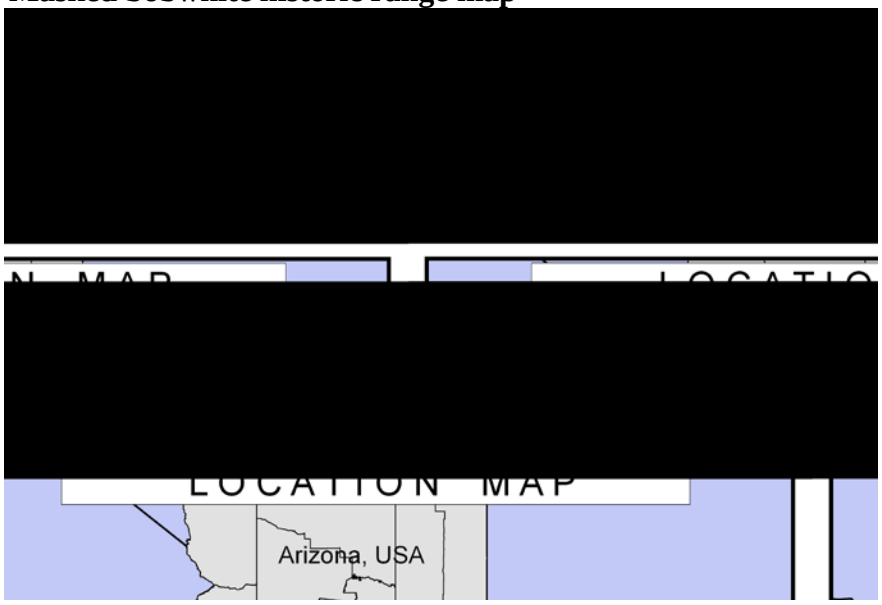
2.3.1.5 Spatial distribution, trends in spatial distribution (e.g. increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g. corrections to the historical range, change in distribution of the species' within its historic range, etc.):

The rarity of the masked bobwhites makes determination of their current (and past) distribution difficult. The few that have been detected in recent years in the U.S. and in Mexico are well within their historic range of occurrence. But habitat fragmentation, drought, buffelgrass invasion, and predation have made their occurrence spotty, at best.

Sightings within Arizona have been reported throughout the Altar Valley since 2000. A recurring report of birds comes from the Three Points area at the far northeast end of the Altar Valley, just south of Arizona Highway 86. This report has remained unverified. Refuge biologists have reported seeing birds 7 mi (11 km), 18 mi (29 km), and 32 mi (52 km) north of the refuge. Occasionally, staff and refuge neighbors have reported hearing or seeing bobwhites in the Arivaca, Arizona area on a private ranch southwest of the refuge near Sasabe, Arizona and southeast of the refuge on land managed by Coronado National Forest. A few pockets of birds apparently exist outside refuge bounds. No reports have come from immediately south of the border in Mexico. However, the area immediately south is sparsely populated and it is unlikely that residents of the area would cross the border to report masked bobwhites to BANWR staff.

Within central Sonora, Mexico, detections have become increasingly rare. Occurrence at Rancho Grande appears to be unlikely and the birds have been considered extinct at Rancho El Arpa since the early 1990s. But a recent series of interviews with residents of central Sonora conducted by Reina-Guerrero and Van Devender (2010) have produced reports of possible masked bobwhite sightings both in the Benjamin Hill, Sonora area and elsewhere, including the vicinity of El Arpa. These are anecdotal and unverified by biologists. But with the difficulty of finding such a rare species within the historic range, we cannot with certainty declare it absent.

Masked bobwhite historic range map



2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Habitat characteristics: According to Guthery et al. (2000), masked bobwhites use habitat patches with higher canopy coverage of woody plants than is randomly available to them. They select for 10-45% brush cover in Sonora and 20-100% brush cover in Arizona. Guthery also reported that the habitat component most lacking in Sonora was canopy coverage of woody vegetation, with about 48% of the habitat being unusable because of a lack of woody plants. In Arizona, the greatest habitat deficiency was in quantity of herbaceous cover, followed by ambient temperature at 15 cm aboveground and low canopy coverage of woody vegetation. The primary habitat deficiency results in an increased exposure to aerial predators. Increases in canopy coverage of low brush or a functional equivalent (tall herbaceous cover) would provide escape cover from these predators, and increase the quantity of "usable space" (Guthery 1997) in both Mexico and the United States.

Non-native species: Despite findings by Flanders et al. (2006) showing that ground foraging bird species in southern Texas were less abundant on study sites dominated by the non-native Lehmann's lovegrass (*Eragrostis lehmaniana*), King (1998) demonstrated that the number of masked bobwhite observations were similar between areas dominated by native vegetation and those containing Lehmann's. Native vegetation was always found nearby, however. Similarly, Kuvlesky et al. (2002) found that masked bobwhites in Sonora were frequently found in pastures containing another non-native species, buffelgrass, especially during droughts. He thought that the buffelgrass provided appropriate escape and nesting cover when no other types of cover were present.

Though bobwhites may utilize the non-native grasses to some degree, the invasive nature of both the Lehmann's lovegrass and the buffelgrass promote the establishment of monocultures. This aspect of these particular grasses reduces the plant species diversity (8-12 native perennial grass species, 12-16 perennial forb species) needed for the bobwhites existence (U.S. Fish and Wildlife Service, 2010). In addition, buffelgrass monocultures often become too dense which inhibits the ability for bobwhite to move through these areas.

Habitat restoration: In light of his observation that a primary habitat deficiency for masked bobwhites is inadequate herbaceous cover, Guthery (2000) recommended use of mechanical treatments that fracture the soil surface and permit water to infiltrate to augment grazing management. They observed improved quantity and diversity of herbaceous cover in Sonora with disking and soil aeration.

BANWR has implemented soil aeration treatments on a limited basis since 2005. Preliminary monitoring results have shown increased forbs, more robust native perennial grass clumps, and longer periods of green vegetation in aerated areas vs. adjacent un-treated sites (BANWR unpub. data). In 2010, refuge staff aerated 123 acres and, in 2011, 581 acres of grassland were aerated to improve forb availability for masked bobwhites.

In 2010, BANWR received funding through the American Recovery and Reinvestment Act (ARRA) for masked bobwhite habitat restoration. Because of this "stimulus funding" the refuge was able to contract out 1,199 acres of mechanical mesquite removal, improve water retention capacity in 11 stock ponds, and improve 6 wells which will provide water for quail guzzlers. In addition, funding was used for cultural compliance surveys on 14,000 acres enabling future ground-disturbing habitat improvement work to take place.

In Mexico, more mechanical treatments have been tried. Disking has been quite successful (G. Camou pers. com. 2004) in the past in producing native grasses and forbs. Since 2005, contour berm construction has been the range treatment of choice amongst ranchers. This technique produces raised berms of soil which trap rainwater that would otherwise flow off the land. In this way, they believe that grass and forb growth is improved due to increased water penetration and retention.

Habitat Amount and Quality: Bobwhite habitat conditions have been declining in Sonora, Mexico since approximately 2001, as a result of extreme drought, coupled with continued grazing, which has literally eliminated grass from the ecosystem. For several years, habitat conditions were poor and bobwhites virtually disappeared from the landscape, except for one small portion of one private ranch. With the onset of better monsoonal rains in 2007, grassland conditions changed rapidly with better than average grass growth ensuing.

Conditions were good in 2008 as well, but declined somewhat again in 2009 due to low rainfall (BANWR unpublished data). According to Sonoran ranchers, 2010 was an extreme drought year with habitat conditions deteriorating drastically.

On BANWR, habitat conditions have never been optimal for masked bobwhite. The non-native Lehmann's lovegrass and native, yet invasive, velvet mesquite (*Prosopis velutina*) dominate the landscape. The leguminous shrub layer, that characterizes higher-quality masked bobwhite habitat in Mexico, is nearly absent in the valley bottom portion of BANWR. It is unknown whether this habitat component was always absent, or if downcutting of drainages, caused from historic over-grazing, eliminated the shrubs which once grew there. It has also been suggested that the active prescribed burn program has reduced the presence and/or size of shrubs. This leguminous shrub layer seems to provide crucial sources of winter food, according to masked bobwhite biologists (S. Dobrott, J. Levy, R. Tomlinson, pers. com. 2004).

2.3.1.7 Other:

Captive Rearing and Reintroduction techniques: Gall et al. (2000) reported on variations in traditional release techniques which may have improved the survivorship of masked bobwhite chicks over time. Pre-1995 protocols called for pairing 12-15 two-week old chicks hatched at Patuxent Wildlife Research Center (PWRC), Maryland, with sterilized male Texas bobwhites. The group was raised in a brooder for several weeks and then placed into a flight pen to become accustomed to native vegetation and to hone their flight skills. Then they were released in August through September in refuge habitat that provided adequate cover and protection. Results showed that chicks did not survive past a few weeks. For this reason, refuge biologists decided a new strategy was warranted. In 1995, techniques were changed to pairing day-old Patuxent-raised chicks with foster parents (either Texas bobwhites or adult masked bobwhites) on brooder shelves kept at 32º Celsius (C) (89.6º F) for two weeks, then gradually reducing temperatures a few degrees each day until 23.8º C (74.8º F) was reached. Family groups were placed in flight pens 4.5 weeks after introduction. Birds remained in flight pens until release, which was either early covey season (September-October) or late covey season (March). The change in release timing was intended to mimic the timing of when quail naturally form coveys in order to increase survival. Temporary release pens were then constructed at the release sites and groups, averaging 41.1 birds, were introduced into the pens. After a 7 day acclimation period, during which food and water was provided, the birds were released, with food continuing to be provided for a week following. Again, survival was very poor and further modifications were made to the program.

In 1996, techniques were again changed to ameliorate unusually high cannibalism from the previous year. This was the first year of on-site chick hatching at the new captive rearing facility on the refuge and not at Patuxent. Chicks were paired

with Texas and masked bobwhite foster parents within hours of hatching in hopes of improving imprinting success. Brooder lights were covered with red covers, as recommended by some commercial game bird growers, in hopes of reducing cannibalism which included severe pecking of the chick feet and beaks and sometimes resulted in death. Brooders were curtained to retain heat better. Survival appeared to be improving but there were concerns about using the sterilized Texas bobwhite (explained below).

In 1997 and 1998, Texas bobwhites were eliminated as foster parents at the recommendation of the informal Recovery Committee which was active at that time. Rationale for this action was that vasectomized male Texas bobwhites were pairing with female masked bobwhites and as such were preventing a potential successful mating with a male masked bobwhite which could produce viable offspring. In addition, during follow-up surveys, it was impossible to ascertain how many masked bobwhites were present because the call of the masked bobwhite is identical to that of the Texas bobwhite.

Throughout this time frame, necklace-mounted radio transmitters were used to monitor chick survivorship. While it was not possible to prove statistically that the new protocols adopted between 1995 and 1998 improved survival, circumstantial evidence pointed to improved longevity. The refuge population appeared to increase.

In 2011, a modification of a new technique developed by Tall Timbers Research Station (B. Palmer, pers. com. 2010) was used to prepare birds for release. Immediately following hatching, 3 groups of 12 chicks were paired with female foster parents. Twenty-four hours following successful adoption inside a small pet carrier, the chicks and adoptive mother were placed in small 20 ft. x 20 ft. (6 m x 6 m) pens which had been fitted with landscape cloth around the exterior to block the view of all other bobwhites in adjacent pens. Human contact was minimized, allowing only a few minutes per week for feeding and water maintenance. Within the pens the chicks fed on grasshoppers and native plant seeds from the vegetation within the pens, in addition to the game bird starter feed provided for them. At 5 weeks of age, the birds were fitted with radio transmitters and placed back into their pen with their foster parent for a period of 1 week to become acclimated to the newly fitted radios. At 6 weeks of age the birds were released with their family groups into suitable habitat and provided with food and water for several weeks. The chicks upon release appeared to be wild-acting, flushing as a group from the game bird carriers used to transport them to the release sites. Refuge staff applied standard radio telemetry techniques to monitor bird dispersals, identify and document habitats used and assess predator impacts.

A parent reared, natural nesting strategy was also implemented in 2011. This involves pairing a male and female masked bobwhite in a 20x20 pen in mid-June, just prior to breeding season. The intention is to have this pair mate, nest and

hatch a brood of their own. The family unit remains in the pen for approximately 5 weeks after hatch and then released on refuge. Some are released with transmitters. Not all pairs placed in the pens breed, so there have only been a few groups released on refuge to date.

Although survival appears to be better using the 2 new strategies above, overall it is still very poor with all birds determined dead after 6 weeks of monitoring. Given that these are both new strategies, there could be some fine tuning of the techniques and more data could be collected in order to determine the true survival rate. Rearing and releasing captive birds involves an adaptive management strategy with continual modifications needed in order to improve upon what has been done in an attempt to increase the survival rates.

The use of necklace style transmitter have proven to be a challenge over the years but, to date, are the only style that has been used on the quail. Although in later years, the birds were allowed to acclimate to the transmitters prior to be released, the necklace style would often spin around the neck and possibly interfere with proper movement of the bird. It is believed that the birds released with transmitters are much more vulnerable to predation compared to those without. This makes determining true survival rates difficult.

The survival and movement data associated with all the release strategies used over the years has not been fully entered or analyzed. What has been entered thus far is part of the refuge's GIS database, but the data entry needs to be completed. Survival has proven to be poor for the most part and it has been decided that such an analysis would not be an efficient use of time. Modifications made to the release strategies were made as a result of observational/incidental data that led refuge biologists to believe a change to the strategy was warranted.

Disease: The captive flock at BANWR has been prone to disease outbreaks, typically of unknown origin. The most notable of these occurred in 2007, when disease swept through the facility decreasing the flock from over 600 individuals to fewer than 300 in a matter of weeks (BANWR unpub. data). Since the BANWR captive facility does not have a veterinarian on staff, nor on-call, veterinarians from the Phoenix Zoo trained BANWR staff in veterinary techniques to treat the sick birds, and biologists from other refuges assisted. A total of 250 of the most valuable birds were treated 1-2 times daily. When the crisis subsided, it was found that they were suffering from pseudomonas (a bacterial infection), one or more viruses, and quail enteritis (an intestinal malady of bacterial origin). The flock rebounded, and following the breeding season numbers swelled to 1100.

Another sweeping outbreak of disease occurred in 2010. At this time over 250 adult birds were lost. But the situation escalated when chicks began dying. By mid-summer, after producing 1332 fertile eggs and hatching 1085 chicks, we only had a 7% survivorship rate. Breeding was continued, however, and isolation

protocols were implemented wherein cohorts of chicks from each hatch were placed into closed rooms within 3 different buildings on BANWR. Deaths subsided and the survivorship rate of this second portion of the hatch was 45%, normal for the captive flock.

A flock of bobwhites loaned to the Phoenix Zoo experienced a die-off during 2006-07 (20 additional birds were given to Phoenix Zoo in 2013). In this case, avian malaria was detected. At first it was suspected that contact with Gambel's quail was responsible, as both Gambel's, and some bobwhite quail, showed identical *Haemoproteus* spp. infection, though no clinical signs of disease. Some bobwhites were found to be infected with a *Plasmodium juxtanucleare*-like organism found in common ravens, located in an adjacent display, which may be responsible for the disease symptoms which ultimately caused the bobwhite's death. Birds tested at the BANWR facility from which all the masked bobwhite originated showed no sign of either organism. The conclusion was that suppressed immune systems or lack of exposure to both organisms may make these captive masked bobwhites especially vulnerable (Pacheco et al. 2011).

Since 2001, there have been thousands of newly hatched chicks which died of apparent starvation at the BANWR captive facility. Generally, deaths occur within the first week of life with chicks appearing to feed, but not ingesting food. It has been suggested that the cause may be due to husbandry rather than to disease, since there have never been any conclusive necropsy findings other than starvation. In fact, chick survivorship appears to have increased since the onset of feeding a different, presumably higher-quality, food (BANWR unpublished data). Unfortunately, this data has not yet been analyzed.

The occurrence of disease in the captive facility which houses all of BANWR pen-reared masked bobwhites is a serious event. This is exacerbated by the fact that 98% of the world's masked bobwhites are housed within this captive facility. The longer this situation persists, the greater the chance becomes that a single stochastic event will result in extinction of the bird.

The San Diego Zoo and the Phoenix Zoo have both expressed interest in being more involved with the masked bobwhite program. Both zoos have MOUs with the USFWS for multi species conservation and have submitted proposals to USFWS requesting funds in order to assist in managing the captive flock. The Phoenix Zoo and BANWR also have an MOU specific to masked bobwhite. In addition, the Phoenix Zoo is in the midst of building a multi-species conservation center in which a portion of the building is intended for masked bobwhite. The zoos have been discussing ideas about working together to raise, release and conduct research on refuge to evaluate survival. In order for the masked bobwhite program to be successful, it is critical to establish a long term partnership (funding) with zoological institutions that have the expertise surrounding avian health.

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range:

Grazing

Mexico

Since its rediscovery in 1964, the masked bobwhite initially surged in numbers, probably due to habitat improvements implemented by local ranchers. Numbers have since dropped to near zero following a period of drought and continued grazing in the early 2000s (BANWR unpublished data).

In Sonora, Mexico, cattle ranching is a major occupation with 90 percent of the land base devoted to this activity (Perramond 1996). Not only is a large portion of the land base devoted to grazing, stocking rates tend to be 2-5 times the recommended levels (Nabhan and Holdsworth 1999). This phenomenon is likely due to the large amounts of private and communal land, less regulation, and the dependence of the population on farming and ranching.

In the ranchland south of Benjamin Hill, Sonora, where the masked bobwhite lives, grazing is the primary activity and the land conditions often reflect this. Grazing continues during times of drought, sometimes until no grass exists. This practice has temporarily reduced, and it is speculated that in some cases, it has eliminated masked bobwhite habitat.

However, a recent renewed interest in masked bobwhite, accompanied by funding from the Turner Foundation in the United States has prompted two landowners to defer grazing on portions of their lands and implement soil aeration, disking, and planting of native plants, plus eradication of buffelgrass, which has resulted in improved conditions in masked bobwhite habitat. Unfortunately, this renewed interest may be too late, as intensive surveys of recent years cannot confirm even a single bobwhite in Sonora. A Conservation Agreement between USFWS and two Mexican ranchers was put in place in 2006 and interest in masked bobwhite conservation remains strong.

Arizona

Currently there is no legal livestock grazing activity on BANWR. Occasionally, cattle from adjacent private ranches stray onto the refuge, but these are promptly removed from the refuge by their owners.

In the early 2000s, trespass grazing from Mexican cattle, sheep and goats was a common occurrence in the southern portion of the refuge. Ranchers south of the

border were cutting fences and moving livestock onto the refuge at night and herding them back into Mexico in the daytime. This practice persisted for several years and effectively denuded 3500 acres along the border. After the border fence was constructed, illegal livestock grazing was eliminated since the fence prevented movement of cattle onto refuge lands. The herbaceous grass cover has regenerated to a great degree.

The bulk of the Altar Valley, Arizona, in which BANWR resides, is dominated by ranchland in private and state ownership. In Arizona, intensive livestock grazing, coupled with drought, which has been implicated in the extirpation of the bird from the state by 1900 (Sayre 2002), has produced a secondary impact which may be harmful to the planned reintroduction of the species. Following the removal of vegetation by grazing, heavy rains eroded the soil causing severe down-cutting of drainages. This has permanently altered the hydrological regime of the area. Water tends to run off rather than be retained in the soil making the shallow drainages once used by masked bobwhite and formerly vegetated by sacaton grass (*Sporobolis* spp.) and leguminous shrubs, difficult or impossible to restore in these areas.

Fragmentation

Mexico

Throughout the historical range of masked bobwhites, fragmentation of habitat threatens the continued existence of the bird. Contiguous masked bobwhite habitat is limited due to the cultivation of buffelgrass monocultures and the heavy grazing practiced throughout the bird's range.

Currently, the habitat on 4 ranches in the Benjamin Hill, Sonora area, is in good condition and conservation agreements have been used to suspend grazing on 3,200-5,000 acres on two of these ranches for 3 years and implement mechanical habitat treatments. Elsewhere in Sonora, ranches are being examined for their suitability for masked bobwhite, with few being located that show any promise.

Arizona

Though BANWR was created to promote the conservation and recovery of the masked bobwhite, good masked bobwhite habitat is rare and occurs in smaller patches which may only be able to support a single covey in each of these areas. The lack of leguminous shrubs, and the mid-story layer in general, may prohibit the use of much of BANWR by the masked bobwhite. Other areas exist within the Altar Valley, however, which may provide adequate habitat and which, at least anecdotally, may have been occupied already by a few birds within the past 10 years.

In 2010, the BANWR Habitat Management Plan was finalized. This document will facilitate implementation of masked bobwhite habitat improvements on the refuge. Mesquite removal is already occurring, soil aeration is being implemented, water sources are being created or improved, and a small revegetation project has begun.

Spread of Exotic Grasses

Mexico

Although a few of the private ranches in Sonora, Mexico, exhibit good habitat management practices, the majority have embraced the planting of the exotic invasive buffelgrass. Since its introduction in the 1950s as a high-value forage grass capable of withstanding drought, grazing and erratic rainfall events (Franklin et al. 2006), it is difficult to estimate the total amount of desert scrubland that has been converted or affected by buffelgrass. The process of conversion often involves chaining or bulldozing native vegetation prior to seeding of this exotic. This removal of native vegetation via chaining or bulldozing, negatively affects the natural desert ecosystem in several different ways. The removal of the native plant species reduces habitat and food resources for all the wildlife that evolved to depend on them (Burquez-Montijo et al. 2002). Conversion of native vegetation to pastures has been associated with soil erosion and changes or reductions in nutrient dynamics and primary productivity (Franklin 2006), all of which make it difficult or impossible for native plants to reestablish. Conversion to buffelgrass greatly decreases plant species richness, due to its fast-spreading and invasive nature (Franklin et al. 2006). With the spread of buffelgrass comes the risk of fires in habitats that, in many cases, did not evolve to withstand fire, at least not of the intensity produced by dense stands of this non-native grass (Freifelder et al. 1998).

While masked bobwhites will use pastures containing some buffelgrass, and while they are known to nest in buffelgrass clumps (W. Kuvlesky pers. com. 2005), pastures are typically converted to a near monoculture of the exotic grass and quickly become unsuitable for bobwhites. The species diversity required by the bird is lost, the availability of bare ground required for feeding is reduced, and so the area becomes incapable of supporting bobwhites (U.S. Fish and Wildlife Service 2010)

Arizona

Exotic grasses have played a large role in the degradation of masked bobwhite habitat in the United States, as well as Mexico. Buffelgrass has invaded into areas occupied by desert scrub and grassland, but not to the same extent as in Mexico. On BANWR, buffelgrass sites are recorded annually but most have been eradicated to date. Buffelgrass still poses a threat to habitat due to its prevalence in the Tucson area and its expansion down State Highway 286 in the direction of

the refuge.

The primary exotic grass affecting bobwhite habitat on BANWR is Lehmann's lovegrass. This exotic was planted in the 1970s by the ranchers who owned what is now refuge land. The preferred nest substrates for masked bobwhites include native perennial bunch grasses which provide the necessary cover for the nest construction. Lehmann's lovegrass creates a dense thatch ground cover and is therefore unsuitable for bobwhite use. Furthermore, seeds from this grass species are too small for consumption by the birds. In addition, the dense growth of the lovegrass promotes larger and hotter wildfires than what occurred historically within these native Arizona rangelands.

Fire

Mexico

While prescribed fire was historically used in the Rancho El Carrizo area near Benjamin Hill Sonora, at least on a small scale, no burning has taken place in the area within the past decade, and possibly longer (E. Gomez pers. com. 2009). Instead, mechanical treatments have become popular among ranchers.

Arizona

Prescribed fire has been used as a tool on BANWR since 1988 to restore masked bobwhite habitat. At that time the thinking was that after a century of overgrazing and fire exclusion accompanied by introduction of Lehmann's lovegrass, large scale habitat improvement was necessary to rehabilitate the land. Initially, burns were done in the spring. In 2001, hot season (May-early July) burns commenced in an effort to mimic the time at which natural fires occurred. At first 15,000-20,000 were burned annually. Burn blocks were typically 1,000-6,000 acres. Goals were to restore native grasses and reduce mesquite cover. Mesquites, for the most part, were not killed by the fire, but temporary top-kill reduced them to a shrub-like form thought to be usable by masked bobwhites. (U.S. Fish and Wildlife Service 2001). However, prescribed burning may also directly result in "take" of masked bobwhite, and the BANWR's burn program has undergone section 7 consultation in order to address the effects of the prescribed burn program on masked bobwhite.

With the completion and signing of the Habitat Management Plan (HMP) in 2010, total burn acreage is limited to 9,000 acres per year, with burns within the masked bobwhite zone limited in size to 50-100 acres. While the smaller burns are more difficult to accomplish, they are more in line with recommendations for maximum northern bobwhite production which suggest an optimal size of 25-30 acres (Palmer 2010). Large-sized burns are still planned for other refuge program goals such as restoration of pronghorn habitat.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Factors other than habitat degradation may have contributed to the decline of the species. Historically, local overexploitation may have occurred particularly in Mexico where, at least anecdotally, bobwhites were hunted. Bobwhites have been so rare in Arizona and Sonora in modern times that hunting of the species would be unproductive. Neither hunting, nor collecting, of masked bobwhite is currently known to be in practice in either the U.S. or Mexico.

2.3.2.3 Disease or predation:

Predation and disease potentially could be having an impact on bobwhite populations. BANWR has a very high density of predators. Known to have one of the highest concentrations of coyotes in Arizona (Arizona Game and Fish Department unpublished data, Jim Hefflefinger pers. com. 2006), the area also supports very high numbers of raptors. Most deaths of adult radio-collared masked bobwhites were attributed to raptors (Goodwin 1982). Increased occurrence of raptor perches due to the invasion of velvet mesquite (*Prosopis velutina*) may be responsible. Although quantitative data are lacking, the potential for nest predation is high due to the large number of snakes, skunks, raccoons, bobcats, gila monsters, road runners, ants, coyotes and foxes.

Raptor numbers are significantly lower in Sonora than on the refuge, therefore, it is believed that raptor predation in Sonora is less common. For unknown reasons, hawks are not common in the central Sonoran habitat utilized by the bobwhites. Many predators, especially mammalian, are dispatched by ranchers in the area, but high numbers of reptilian predators are present in the vicinity.

Disease, while not identified in the wild population, has been of concern in captive flocks. As discussed above, at the captive breeding facility on BANWR quail have been diagnosed with quail enteritis, unknown viruses, and pseudomonas on several occasions (BANWR unpublished data). In addition, amyloidosis is a common problem which is possibly symptomatic of stressful conditions, inbreeding or injury. Recently, a flock of captive masked bobwhites at the Phoenix Zoo contracted a form of malaria apparently passed to them from other wild birds (Pacheco et al. 2011). This could be important as it may affect reintroduction attempts in both the U.S. and Mexico.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Regulatory mechanisms appear to be adequate to protect the masked bobwhite in both the U.S. and in Mexico. The masked bobwhite quail has been on the Federal endangered species list since the passage of the Endangered Species Conservation Act of 1969 (Public Law 91-135, 83 Stat. 275). This act was superseded by the Endangered Species Act of 1973 (50 CFR 17.11; Public Law 93-205, 87 Stat.

884; 16 U.S.C. 1531-1540), as amended. The status is valid wherever masked bobwhites exist in the U.S. and Mexico.

The masked bobwhite is also listed by the Government of Mexico as endangered in Mexico (SEMARNAT 2010). It is in Appendix I of CITES as a species in danger of extinction and is listed as near threatened by the International Union for Conservation of Nature and Natural Resources. As an endangered subspecies of a popular game bird, harvest is illegal.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Hurricanes

Other natural or manmade factors may be implicated in the endangerment of the masked bobwhite. In Mexico, anecdotal information gathered from ranchers in the Benjamin Hill, Sonora area, indicates that Hurricane Lester, in 1992, may have affected bobwhite populations. Ranchers said that bobwhite corpses were found on higher points in the flat valley bottom. It appeared to them that the quail had congregated on high ground, and raptors predated the flocks. This possibility is substantiated by biologists from the Centro Ecológico de Sonora who were surveying for bobwhites and became stranded for over a week due to high water and mud (E. Gomez pers. com. 2008). Other hurricanes and intense monsoonal storms impact the area regularly and produce standing water conditions which coincide with the masked bobwhite nesting season.

Climate Change

Our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). The term “climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007a). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007a).

Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has been faster since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions. (For these and other examples, see IPCC 2007a; and Solomon et al. 2007). Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and is “very likely” (defined by the IPCC as 90

percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (IPCC 2007a, Solomon et al. 2007). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011), who concluded it is extremely likely that approximately 75 percent of global warming since 1950 has been caused by human activities.

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (e.g., Meehl et al. 2007, Ganguly et al. 2009, Prinn et al. 2011). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2030. Although projections of the magnitude and rate of warming differ after about 2030, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by the extent of GHG emissions (IPCC 2007a, Meehl et al. 2007, Ganguly et al. 2009, Prinn et al. 2011). (See IPCC 2007b for a summary of other global projections of climate-related changes, such as frequency of heat waves and changes in precipitation. Also see IPCC 2011 for a summary of observations and projections of extreme climate events.)

Various changes in climate may have direct or indirect effects on species. These effects may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007). Identifying likely effects often involves aspects of climate change vulnerability analysis. Vulnerability refers to the degree to which a species (or system) is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the type, magnitude, and rate of climate change and variation to which a species is exposed, its sensitivity, and its adaptive capacity (IPCC 2007a, see also Glick et al. 2011). There is no single method for conducting such analyses that applies to all situations (Glick et al. 2011). We use our expert judgment and appropriate analytical approaches to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

Although many species already listed as endangered or threatened may be particularly vulnerable to negative effects related to changes in climate, we also recognize that, for some listed species, the likely effects may be positive or

neutral. In any case, the identification of effective recovery strategies and actions for recovery plans, as well as assessment of their results in 5-year reviews, should include consideration of climate-related changes and interactions of climate and other variables. These analyses also may contribute to evaluating whether an endangered species can be reclassified as threatened, or whether a threatened species can be delisted.

Global climate projections are informative, and, in some cases, the only or the best scientific information available for us to use. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (e.g., IPCC 2007a). Therefore, we use "downscaled" projections when they are available and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species (see Glick et al. 2011 for a discussion of downscaling). With regard to our analysis for the masked bobwhite, downscaled projections are available for portions of its range.

Climate change is among other natural or man-made factors which may affect the masked bobwhite in both the U.S. and in Mexico. Localized projections suggest that the southwestern United States may experience the greatest increase in temperature of any area in the lower 48 states (IPCC 2007) with warming being greatest in the summer. Precipitation is expected to be reduced during the winter and spring, as the jet stream, that normally transports rain and snow, moves into a more northerly position, bypassing the southwest more often than it currently does (Lenart 2008).

Summer rainfall patterns, although intense, typically operate at a much smaller and localized scale than winter rainfall, therefore are more challenging to predict. Some experts predict decreased summer rainfall due to a northward shift of the subtropical anticyclone, the pattern that helps set up the monsoon. Other factors, however suggest increased summer precipitation (Lenart 2008).

Effects of climate change on masked bobwhite are unknown. We speculate that increased monsoonal moisture may be beneficial for the masked bobwhite by producing growth of herbaceous vegetation and increasing seed production of leguminous shrubs. Additionally, increases in summer monsoon precipitation would likely provide conditions needed to trigger and/or prolong breeding behavior in masked bobwhites (BANWR staff per obs) and thereby improve nest success. However, if winter rainfall becomes diminished or more sporadic, the growth of forbs in the late winter/early spring may impede the breeding condition, if not the outright survival of bobwhites, as the herbaceous growth, seeds and insects stimulated by winter rains serves to satisfy the birds needs until the onset of the monsoon.

As temperatures rise, the availability of smaller sized insects of the size suitable for consumption by chicks may become unsynchronized with the peak of quail hatch (N. Silvy pers. com. 2007). Grasshoppers, which are an important chick food, may already be occurring in a size too large to be effectively consumed by very young bobwhite chicks whose hatching peak occurs in early September (BANWR staff observations).

Significant changes in climate which are occurring or which have already occurred may affect the release program for pen-reared masked bobwhite. If habitat conditions become increasingly unsuitable to sustain these birds throughout the year, then quail may need to be relocated to areas outside their historic range to areas that approximate the correct conditions for bobwhites.

2.4 Synthesis

Information generated since 1995 updates our understanding of the status of the masked bobwhite, its threats, and recovery potential. With the bulk of the world's population of masked bobwhite being held in captivity, primarily at BANWR, the success of the captive breeding program is critical to the bird's survival. Bouts of disease have decimated the BANWR captive flock on 2 occasions and have threatened the species' existence. While diseases of masked bobwhites are not known from the wild population, the species to species spread of a malaria-causing organism at the Phoenix Zoo, in particular, is of special concern.

The construction of a new captive breeding facility in Mexico holds promise for species perpetuation. A shift in techniques for conditioning captive birds to prepare them for release, as well as new parent-rearing techniques, hold promise for creating wilder, more robust birds for reintroductions.

When compared to other subspecies of northern bobwhites, the masked bobwhite appears to be a true subspecies. Captive releases of other subspecies have been so widespread across North America that the distinctions between subspecies have blurred.

Genetic variability of the captive flock, and therefore the release birds, may play an important role in the success of the reintroduction program. Signs of inbreeding have already appeared within the captive population, though results of the flock's pedigree showed what appeared to be higher variability than expected. Still, the variability was lower than that of wild Sonoran masked bobwhites and the closely related Texas bobwhites. The translocation of wild Mexican masked bobwhites to BANWR in 1999 appeared to contribute to the longevity of a wild population in the central portion of the refuge, possibly due to the higher genetic variation.

Reproductive potential of the masked bobwhite appears to be less than that of other northern bobwhite subspecies due to the relationship between the onset of reproductive condition and the humidity and warmth of the summer monsoon season. Temperature and moisture seem not only to affect reproduction, but cold temperatures may increase winter mortality based on casual observations of the captive birds.

Predation may have a substantial impact on bobwhite populations. Raptor predation is especially noticeable on BANWR, where hawks and owls appear to be the main predator on adult birds, based on telemetry studies. High populations of mammalian and reptilian predators may also be affecting this ground-nesting bird. Predation pressure does not appear to be as acute in Mexico where predator control is implemented and raptors do not appear to be as naturally abundant.

Habitat loss and alteration may be primarily responsible for the bird's apparent demise. Studies done in Mexico and the U.S. show deficiencies in important components, such as woody vegetation (shrubs) and herbaceous cover. Introduction of non-native grasses, such as buffelgrass and Lehmann's lovegrass, have created monocultures which result in habitat conditions opposite to the diverse habitat that this species requires. Over-grazing is a problem, at times, in Mexico, and has had devastating effects in drought years.

Habitat for masked bobwhites currently exists as islands within grassland and mesquite woodlands. Currently, we do not know where all appropriate habitat exists nor do we know where all masked bobwhites actually exist. At this time, work is being done to identify and locate additional populations and habitats.

Habitat restoration has begun on both sides of the border. Mechanical treatments and prescribed fire are being utilized in an attempt to create appropriate habitat conditions. Revegetation with native plant species is beginning, and grazing deferments have been used in Mexico in an attempt to retain good bobwhite habitats on private lands.

Climate change may have an important and detrimental effect on the masked bobwhite. Reduction of winter rains and change in summer monsoon patterns may reduce chances of survival of the bird. It is too early to predict the outcome of change in weather patterns, but it may be necessary to consider releasing birds in areas outside their historic range by locating habitats which closely resemble those known to be used by the bird. Normal or above average precipitation, during both the winter and monsoon seasons, over a few consecutive years may do more for conserving masked bobwhite than any other action we undertake.

Surveys for masked bobwhite have shown lack of a self-sustaining population on BANWR, and almost zero birds now occur on traditionally occupied areas in Mexico. Overall, survey results in both the U.S. and in Mexico show downward trends, with numbers approaching zero in both countries.

We recommend that the endangered status of the masked bobwhite quail remain unchanged. The possibility of extinction is high due to continued habitat loss in Mexico from the widespread planting of buffelgrass and rangeland degradation, continued poor quality habitat in the United States, drought, and, possibly, from effects due to global climate change.

3.0 RESULTS

3.1 Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (*Indicate reasons for delisting per 50 CFR 424.11):*
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X__ No change is needed

3.2 New Recovery Priority Number: No change needed. The recovery priority number should remain at 6.

Brief Rationale: This is a highly endangered subspecies with a poor chance of recovery. A Recovery Priority Number of 6 indicates that: (1) the masked bobwhite was listed as a subspecies; (2) populations face a high degree of threat; (3) recovery potential is low; and (4) recovery of the masked bobwhite is not likely to be in conflict with construction or other development projects.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Most of the recovery actions delineated in the Recovery Plan (U.S. Fish and Wildlife Service, 1995) have not yet been implemented. In addition to those, new actions have been identified which are important, if not essential, for the survival of the masked bobwhite. Recommendations for future actions are described below.

Captive Management

Recruit additional breeding facilities both in the U.S. and Mexico. The Five Year Interim Action Plan (U.S. Fish and Wildlife Service 2010) for the masked bobwhite has prioritized actions deemed essential by the Recovery Team for the continued survival of the species. The current state of the wild population underscores the importance of the captive flock. In addition to constructing new facilities, appropriate professional support should be provided, including expertise in veterinary medicine, aviculture, nutrition, behavior, genetics, and data management (Recovery Actions 1.1-1.4, 2.54). The captive rearing program should be outsourced to zoological facilities both in the U.S. and Mexico and rearing and release efforts should be emphasized more in Mexico. In particular, we should continue to support the new captive breeding facility at Africam Safari in Puebla, Mexico and transfer masked bobwhite from BANWR to Africam.

In the absence of additional resources, efforts to raise and release masked bobwhite should be ceased on BANWR. Efforts to establish a self-sustaining population of masked bobwhite in the Altar Valley, AZ have been ongoing for nearly 50 years (28 years as a National Wildlife Refuge). Many rearing and release methods have been attempted, but there are many natural

factors working against the success of the program (i.e. predators, climate change, captive birds, habitat, temperature extremes, genetics), and a self-sustaining population of masked bobwhite has not been established. In the United States, recovery efforts for this species have been generally underfunded and, as a result, the habitat has not been managed properly. Personnel and equipment have been and remain inadequate to propagate the birds in optimum conditions or prepare quality habitat for their use once released. The geographic location of BANWR is at the northernmost portion of the bobwhite's range which makes optimal habitat difficult and unlikely to attain.

Develop data management systems for captive population genetics. We should collect all known information on the genetics of the captive population and develop a new genetic management plan which would be used to evaluate masked bobwhite pairing strategy and modify it, if necessary, to optimize genetic health and diversity. In addition, criteria should be developed for masked bobwhite selection and transfer to new captive propagation programs (Recovery Actions 1.1, 1.3, 2.542).

Determine the relative relatedness of various Mexican races of bobwhite (Colinus virginianus). Relatedness has become more relevant as wild populations of masked bobwhite may be extirpated, and other Mexican races could become source populations if a race is found that is indistinguishable or closely related to the masked bobwhite. A project is funded and underway to analyze 20 individuals from each of the five subspecies. The intent is to use any newly gained taxonomic information to aid the recovery efforts for the masked bobwhite, particularly with respect to potential translocations into appropriate habitats in Sonora.

Develop and standardize captive management and reintroduction protocols for the new and existing facilities. Protocols for propagation, rearing, pre-release conditioning, and release techniques should be developed along with a health and disease management plan (Recovery Action 1.1-1.4, 2.54). This will result in the production and rearing of birds that will have a higher chance of survival in the wild.

Reintroduce masked bobwhite in the U.S. and in Mexico. Given the current status of the wild population, reintroduction will be necessary for this bird to survive in the wild. Following the refinement of rearing and release techniques, and the identification of suitable locations, reintroductions should be implemented in the U.S. and in Mexico. Training should be provided for captive propagation personnel (Recovery Actions 1.1, 1.3, 2.542).

Status in the Wild

Assess the status of the wild population. Surveys were conducted from 1968 to the present in known wild populations. The extremely low population indicates a need for extensive searching elsewhere in Sonora for the bobwhites (Recovery Actions 3.11, 3.12).

Existing habitat within the Mexican historical range should be mapped. A systematic and dedicated effort to locate any extant masked bobwhite populations or suitable habitat for reintroductions in Mexico is critical. This can be done by supporting a bi-national team of

biologists to evaluate promising habitat locations in Sonora for remaining masked bobwhite and suitable habitat for reintroductions.

Potential Release Sites

Potential bobwhite release sites should be evaluated and prioritized (Recovery Actions 3.13, 3.2, 3.3, 3.4, 3.51). With the onset and presumed irreversibility of climate change, the habitat needs of the masked bobwhite are even more likely to be unmet. Drying of winters and subsequent loss of production of green vegetation necessary for quail reproduction may thwart breeding attempts. Erratic summer monsoons will likely produce inconsistent vegetative conditions which may prove good in some years, but bad in many others. For this reason, reintroductions may need to be considered outside the bird's historic range. As habitats change, the bird may be more successfully reintroduced into areas either higher in elevation or further north where weather conditions may begin to mimic the historic weather patterns in the heart of their range in Mexico.

Habitat Management

Identify appropriate habitat management strategies in Arizona and Sonora. Land management histories, vegetation data collected on the ground, biophysical information and expert knowledge (e.g., Habitat Suitability Indices) should be used to determine management approaches to achieving desired conditions.

Habitat improvements should be implemented in both the United States and in Mexico (Recovery Action 2.3, 2.4, 3.2, 3.4). Management actions that are recommended should be implemented and the results should be monitored. BANWR should continue to follow the recommendations of the Habitat Management Plan (U.S. Fish and Wildlife Service 2010).

Habitat management actions which would assist bobwhites in avoiding predators should be implemented. The high numbers of predators on BANWR make reintroductions difficult. Avian, mammalian, and reptilian predators are abundant throughout the year. There is no safe season to release birds. Raptors, the primary cause of predation on masked bobwhites, are especially abundant and problematic. Sites with fewer avian predators should be located and considered for potential release sites.

Partnerships with landowners in the U.S. and Mexico should be developed in order to protect and improve habitat (Recovery Actions 2.3, 2.4, 3.211, 3.4, 5). Conservation easements or purchase of land in Mexico should be pursued. The recovery effort in Mexico has been affected by the current management of private land. Continued grazing during times of drought and overgrazing even during periods of adequate moisture has compromised the already waning habitat. The introduction and proliferation of buffelgrass monocultures has reduced the potential bobwhite habitat even further. In times of good climatic conditions, livestock and bobwhites appear to co-exist adequately. A masked bobwhite preserve is likely needed for the species to survive in Mexico (Recovery Action 3.23).

Recovery Plan

The recovery plan should be revised. Given the lack of success thus far, reintroductions and the establishment of 2 self-sustaining populations in Sonora, Mexico, and 2 in the United States (BANWR and one other) may not be attainable and the recovery criteria should be reevaluated (Recovery Actions 2.1. 2.2, 2.5, 3.3, 3.5). The expertise of geneticists, ecologists, captive management specialists and others should be enlisted to revise the plan.

Funding and Outreach

Develop and implement a comprehensive strategy to actively pursue funding for recovery actions. A focused effort is needed to engage both public and private partners in funding opportunities that can be strategically used for recovery actions. Media attention in the US and in Mexico should be actively pursued to increase public awareness about the masked bobwhite.

Research Needs

Many research gaps have been identified and answers to the following research questions should help refine the actions above.

- What are the probable effects of climate change on potential release sites?
- What are masked bobwhite food preferences in both the U.S. and Mexico? (Recovery Actions 2.52, 3.62)
- What is the optimal landscape configuration for cover and food plantings?
- What is the effectiveness of habitat treatments? (Recovery Actions 2.514, 3.613),
- What are the effects of buffelgrass invasion?
- How does insect abundance affect brood survival?
- What are the effects of supplemental water on bobwhite survival and reproduction?
- What are the effects of competition with other quail? (Recovery Actions 2.516),
- What are the predator impacts on quail populations?
- What are the temperature tolerances of masked bobwhites?
- What is the relative relatedness of various Mexican races of bobwhite (*Colinus virginianus*)?

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Experts Consulted

Dr. Roberto Aguilar DVM, Former Director of Conservation and Science, The Phoenix Zoo, Phoenix, AZ, currently Cape Wildlife Center - Humane Society of the US, Barnstable, MA

Karina Santos Del Prado Gasca, Biologist, Director, National Institute of Ecology (INE)

Steve Dobrott, Ranch Manager (former masked bobwhite biologist), Caballo, NM

Dr. Miguel Angel Flores Mejia DVM, Director of International Agreements for Wildlife

Jim Levy, Retired ("re-discoverer" of the masked bobwhite and naturalist), Tucson, AZ

Eduardo Gomez Limon, Biologist, Hermosillo, Sonora, MX

Dr. Benjamin Cuauhtemoc Gonzalez Brizuela DVM acting for General Director of Wildlife, Dr. Martin Vargas Prieto DVM

Brad Mueller, Quail Consultant, American Wildlife Enterprises

Dr. Bill Palmer, Game Bird Program Director, Tall Timbers Research Station, Talahassee, FL

Roy Tomlinson, Retired (former masked bobwhite biologist), Albuquerque, NM

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Masked Bobwhite Quail
(*Colinus virginianus ridgwayi*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Mary Hunnicutt, Dan Cohan, Sally Gall, Buenos Aires NWR, U.S. Fish and Wildlife Service

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service, Buenos Aires NWR

Approve Sally Gall Date 11-6-2013

REGIONAL OFFICE APPROVAL:

for **Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2**

Approve Elizabeth Ann Date 4/29/14

Cooperating Regional Director, Fish and Wildlife Service

X Concur ____ Do Not Concur

Signature Benjamin N. Tuggle Date 5/8/2014