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THE SAGA OF THE MASKED BOBWHITE: LESSONS LEARNED AND UNLEARNED

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ABSTRACT

No bird has generated so much interest and controversy as has the masked bobwhite (*Colinus virginianus ridgwayi*). From its discovery in 1884 to the present, this gallinaceous game bird has captured the attention of hunter-naturalists, ornithologists, collectors, game breeders, conservationists and bureaucrats. Believed threatened with extinction throughout its 130 year history, the masked bobwhite prompted several collecting expeditions, a survey technique study, a plethora of propagation attempts, and the purchase of an 117,464 acre refuge by the federal government, and expenditures totaling millions of dollars. Yet, despite propagated stock existing in a captive facility on Buenos Aires National Wildlife Refuge, the status of the masked bobwhite is now more perilous than ever, and this subtropical race of America's most popular game bird may now be functionally extinct. How this all came about is a lesson that needed to be learned by wildlife managers seeking to increase and secure wild populations of native game birds.

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Key words: Buenos Aires National Wildlife Refuge, Arizona, *Colinus virginianus ridgwayi*, masked bobwhite, propagation, Sonora, Rancho Carrizo, restoration

INTRODUCTION

The story of Herbert Brown's discovery of the masked bobwhite in Arizona and subsequent attempts to prevent the bird's extinction has been told several times (Tomlinson 1972a, Brown and Ellis 1977, Kuvlesky and Dobrott 1995, and most recently, Hernández et al. 2006, and Brown et al. 2012). Only 13 native masked bobwhite from five general locations in Arizona are in collections, all through Herbert Brown's efforts (Brown et al. 2012). By 1900, bobwhite could no longer be found in Arizona and the bird had disappeared before any attempt could be made to obtain aviary specimens or protect any of the wild bird's natural habitat (Brown 1900, Brown 1904, Breninger 1904).

After 1904, ornithologists concentrated on collecting masked bobwhite in Sonora, Mexico, where Frank Stephens had collected the original type specimen in 1884. Collectors such as J. C. Calhoun, and W. W. Brown scoured Sonora's *llanos* and *bajios*, not only to collect specimens, but also to describe the bird's habitat, and report on its distribution and abundance. Such activities were greatly curtailed, however, with the onset of the Mexican Revolution in 1910 and the Yaqui wars that followed through the 1920s. For some reason none of the expeditions seeking bobwhite extended southward into

Sinaloa, and as far as is known, this race of bobwhite is very isolated (Aldrich and Duval 1954).

With the slacking off of hostilities in the late 1920s, J. T. Wright (1932:73-77) resumed the search for the masked bobwhite in Sonora, not only collecting specimens, but reporting on the bird's presence and abundance while his wife, Dora, mapped its distribution. In July 1931, he found masked bobwhite near Noria on Mexico's Southern Pacific railroad. Later, in October 1931 and March 1932, he found good numbers of bobwhite near San Marcial where he provided definitive habitat descriptions and important life history information. The Wrights' report led to the first attempts to capture masked bobwhite with the intent of restoring the species to the U. S. Unfortunately, the numerous attempts to reintroduce masked bobwhite to Arizona that followed have failed, and wild populations in Sonora may now be extinct. The history of these attempts and a discussion of the reasons for their failure to maintain sustainable wild population is the purpose of this report.

METHODS

We reviewed all of the published literature that was available and as many unpublished reports as we could locate to obtain as much information as possible on former masked bobwhite restoration attempts. That the senior author was professionally involved with this bird from 1964 through 1985, and knew many of the principals

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Fig. 1. Masked bobwhite specimen #78 acquired from an aviary by C. T. Vorhies in 1936. This adult male is thought to have been obtained from the La Cavernas restaurant in Nogales, Sonora, where it reportedly died from old age.

involved, was a major source of information on the early history of restoration attempts. Learning the birds' recent history was greatly facilitated by the second author being a member of the Masked Bobwhite Recovery Team with access to the team's files at Buenos Aires National Wildlife Refuge near Sasabe, Arizona.

RESULTS

Restoration Attempts, 1937–1967

The man who was to dedicate the most time and effort to restore masked bobwhite to the United States was J. Stokley Ligon, who showed an interest in this bird as early as 1913 while collecting birds in New Mexico for E. W. Nelson (Shaw 2011). With the improvement of conditions in Sonora in the late 1920s, interest in the bird revived and several ornithologists from California launched an expedition to obtain aviary stock near Magdalena, Sonora (Sheffler 1931). In 1927, noted oölogists Griffing and Margaret Bancroft stopped at a restaurant near Magdalena, where they ordered quail from the menu. On being informed that they would have to wait

while the birds were killed and dressed, they asked to see the pens where the birds were kept. To the Bancrofts' surprise, the quail within the wire mesh were masked bobwhite. Forgoing dinner, the Bancrofts purchased the live birds for their aviary in Tucson (Walker 1962-63). These quail (and supposedly their eggs) eventually found their way into museums, the final specimen (UAz001350) thought to have been deposited by C. T. Vorhies in the University of Arizona Bird Collection on 15 January 1936 (UAz001350, Figure 1; Brown et al. 2012). This intense subsistence trapping is a heretofore-unreported cause of the masked bobwhite's disappearance similar to that experienced by the imperial woodpecker (*Campephilus imperialis*) (Brown and Clark 2009). No attempt had been made to re-establish this masked bobwhite in Arizona or Mexico.

J.T. Wright had better luck, collecting 44 masked bobwhite between March 1929 and March 1932 in locations from Noria southeastward to vicinities near San Marcial and Tecoripa. Although no live birds were captured for propagation purposes, Wright's habitat descriptions, life history notes, and maps greatly aided further searchers such as Ligon.



Fig. 2. Game Warden and ex-border patrolmen "Pete" Peterson. It was Peterson's fluency in Spanish and interest in masked bobwhite that resulted in masked bobwhite being located in several relict areas in Sonora.

In 1937, Ligon undertook the first of three expeditions to Sonora to obtain wild birds for release and propagation (Tomlinson 1972a). The first trip in December 1937 was made with David M. Gorsuch (1934), who had recently published a monograph on Gambel's quail. This trip resulted in the netting of >100 masked bobwhite in the Tecoripa and San Marcial areas. Other sites investigated included east of La Colorada, near Mazatán, and Laguna Larga (Ligon 1942, 1952).

Thirty-three of these wild-trapped birds were released in the San Rafael Valley and at the Nogales Ranger Station; the remaining birds were held for propagation at Ligon's game farm near Carlsbad, New Mexico. Most of the releases were in temperate short-grass habitats above or at the upper altitudinal limits of the masked bobwhite's historic range as a survey by Arizona Game and Fish Department Federal-Aid biologist O.N. Arrington (1942) found no suitable habitat remained within the bird's historic habitat in Altar Valley. Nor were any of the release sites dedicated to the recovery of masked bobwhite and no advance preparation was made for the bird's survival (Ligon 1942, 1952). Although 10 captive wild birds released at Jalisco Well near Arivaca initially showed promise (Arrington 1943), all of the releases eventually failed (Lawson 1951).

A second trip to obtain brood stock was taken in 1949 with Louis (Buzz) Lawson, the AGFD's Federal-Aid biologist in charge of small game investigations and the Arizona Game and Fish Commission's Game Ranger

George Peterson (Figure 2). Despite spending almost a month during November and December in south-central Sonora, and revisiting the sites visited by Ligon in 1937, no birds were found. Ranchmen, who had formerly known of the presence of masked bobwhite, stated that the birds appeared to have vanished overnight. Ligon and the other investigators knew, however, that the reason for the birds' disappearance was livestock grazing during drought years (Lawson 1951). All indications were that masked bobwhite could not tolerate even moderate grazing of their tropical grassland habitats.

Not willing to give up, Ligon, Lawson and Peterson determined to make a third attempt at finding brood stock as rumors of masked bobwhite in Sonora persisted. After an extensive search in the same general areas for bobwhite feathers in cactus wren (*Camplorhynchus brunneicapillus*) and verdin (*Auriparus flaviceps*) nests in November 1950 a small covey of bobwhite was found near Tecolote Peak 60 miles east of Hermosillo. Then, after a long, difficult trip of > 100 miles, four coveys were located in tall grass near Punta de Agua in southern Sonora. Overall, 25 bobwhite were captured. Lacking proper habitat, but realizing that wild birds were inherently superior to propagated birds, 15 birds were released that year outside the bird's range in southwestern New Mexico and in Garden Canyon on Fort Huachuca. These releases also failed—a situation Ligon and AGFD Research biologist Steve Gallizioli attributed to the bird's being released in unsuitable non-historic habitat, the Garden Canyon birds not being seen >2 months after release. Ligon retained ten birds for propagation (Lawson 1951).

In 1961, the Arizona-Sonora Desert Museum began a study of pen-reared masked bobwhite using 30 propagated birds obtained from Ligon (Walker 1962-63). Knowing that the birds had been in captivity for >20 years and believing that breeding stock might never again be available, Lewis Wayne Walker and Ligon determined that a "do or die" effort must be done as carefully as possible.

After receiving a letter of support from Richard M. Scaife, Chairman of the Board of the Allegheny Foundation, Walker set about coordinating a recovery plan with Arizona Game and Fish Department Director Robert Smith, Arizona Bureau of Land Management Director Fred Weiler, and Arizona-Sonora Desert Museum Director William H. Woodin. Local ranchers were consulted and a revegetation plan pioneered by John Donaldson in which check-dams were used as water retention barriers agreed upon (Walker 1962-63).

After considering 10 different sections of valley land thought to be within the historic range of masked bobwhite, 259 ha of Bureau of Land Management land in Avra Valley were selected, seeded with grasses supplied by the Soil Conservation Service, and dedicated for masked bobwhite restoration. A well was drilled to irrigate the grasses during times of drought and 64 check dams constructed with bull-dozers. On the advice of quail breeders, holding cages of ca 0.5 ha were divided into 16 equal parts 7.6 × 30m. To provide an area for the birds to exercise but not escape, some 372 m² of roof wire,



Fig. 3. Masked bobwhite release site pens and enclosure as they appeared on completion in 1961. Emphasis was entirely on the reseeded grasses with no consideration apparently given to the provision of natural foods.

weighing 4535 kg covered the cages (Figure 3). The total cost was \$15,000 – a sizeable sum for a volunteer organization headquartered in Pennsylvania.

Getting the birds to breed proved a problem as the birds showed little inclination to pair off. Round-tailed ground squirrels (*Citellus tereticaudus*) and kangaroo rats (*Dipodomys* sp.) ate the grass seeds and newly sprouting grasses outside the enclosure. Then disaster struck with the *chubasco* of September 26, 1962. Almost 18 cm of rain fell in 12 hours and visits to the site became impossible.

Fortunately, the cages had been placed on a sandy ridge, and by being on this island, some birds at least, weathered the storm. The source of consternation now was an eruption of black and yellow caterpillars, an infestation so great that chemical applications were considered as a means of control. Not being quail biologists, the Desert Museum caretakers were surprised and delighted when a delayed inspection trip showed two bobwhite fighting over a caterpillar. Later observations that day resulted in hearing at least 2 calling males and finding the remains of two eggs. The damage had been done, however. The check dams had been virtually eliminated and the remaining birds were now fewer in number. How many remained was problematical.

Located in an area dominated by creosote (*Larrea tridentata*), the release site was too dry to support a grassland and was probably outside the bird's historic

range. The project was terminated in 1964 when the few birds remaining in the pen were either eaten or released by two boys from the nearby O'odham Nation. (Brown 1989). The remaining birds were sent to the University of California at Davis in an attempt to discover the reasons for the bird's poor reproductive performance (Tomlinson 1972a). No feral masked bobwhite have been documented from Avra Valley.

At about the same time Jim and Seymour Levy, two Tucson conservation-minded ornithologists, took up the masked bobwhite cause, searching for bobwhite in Sonora and raising propagated stock donated by Ligon, who was now >70 years old. Although hatching the eggs of captive birds proved difficult, their search for masked bobwhite in Sonora with AGFD Research biologist, Steve Gallizioli, succeeded beyond all expectations. In June 1964, while looking for elegant quail (*Callipepla douglasii*) on a ranch in Sonora 26 km south of Benjamin Hill, they saw and heard three coveys totaling *ca.* 20 masked bobwhite (Gallizioli et al. 1967). This ranch, also known as Rancho El Carrizo, differed from former masked bobwhite habitat descriptions in that tall grasses were generally lacking even though the area possessed an abundance of tropical grasses protected from grazing by dense stands of cholla (*Cylindropuntia fulgida*). Although the initial discovery only regarded 120 ha as occupied by bobwhite, later investigations showed some 65 km² to be bobwhite



Fig. 4. The senior author evaluating potential masked bobwhite habitat on Buenos Aires Ranch in 1969 prior to its acquisition as a National Wildlife Refuge. Note the tall grasses (*Sporobolus*) then present.

habitat. These were the first wild bobwhite seen by ornithologists in 14 years.

Realizing that the U. S. Bureau of Sport Fisheries and Wildlife was better equipped to raise masked bobwhite, the Levys donated their four pairs of birds to that agency in 1965. However, after a year of moderate reproductive success at the Patuxent Wildlife Research Center at Laurel, Maryland, both egg production and fertility declined considerably. Patuxent personnel believed that the problem was due to inbreeding depression as the birds had been in captivity for 18 years. (Tomlinson 1972a).

In 1966, the masked bobwhite was included as a species protected by the U. S. Fish and Wildlife Service under the Endangered Species Act. Now that funding was available, the first priority was to see if some sort of arrangement could be made with Sr. Pedro Camou, the owner of Rancho Carrizo, to protect the masked bobwhite's habitat. Initial discussions with Sr. Camou and Mexican officials to set aside or purchase portions of Rancho Carrizo for masked bobwhite preservation were encouraging. Then, for reasons never fully explained, a management agreement to leave some pastures on Rancho El Carrizo ungrazed fell through. Rancho El Carrizo was divided among several owners and Sr. Camou only agreed

to a grazing management plan that would include livestock as well as masked bobwhite on his 1,600 ha ranch (Tomlinson 1972b). Meanwhile, suggestions to purchase an adjacent or other suitable ranch as a masked bobwhite refuge went largely unexplored (Tomlinson 2006a).

Roy Tomlinson was assigned to study the masked bobwhite in 1967. Stationed in Tucson, Tomlinson was an excellent choice having worked as a state and federal biologist on mourning doves and other small game birds. His study began by researching a compendium of all that was known about the "species," searching for additional populations in Sonora, and conducting field studies into the masked bobwhite's life history on Rancho Carrizo. In addition to further investigations into the bird's habitat requirements, these studies included a call-count survey regimen that proved an excellent survey method to monitor masked bobwhite population abundance and declines. Tomlinson's discovery of a second population of masked bobwhite near Mazatán came to naught when the population died out during a drought.

Early Releases and Restoration Attempts

Nearly 60 wild birds were obtained by Tomlinson from Rancho Carrizo during population highs in 1968 and 1969 and shipped via quarantine to the Service's breeding facilities at Patuxent, MD. These birds produced more eggs and chicks than previous attempts, and provided a steady supply of birds for release (Tomlinson and Brown 1970). It was also in 1969 that the U. S. Fish and Wildlife Service, in cooperation with the AGFD, began searching for suitable reintroduction sites in Arizona. Four areas in and near Altar Valley were selected in 1970, none of them ideal. The Arizona sites were higher in elevation (730 to 1310 m) than the bird's Sonoran habitats (290-825 m) and lacked tropical diversity. All of the selected sites were generally rockier and lacked tall, tropical grasses. The Arizona sites were also subject to livestock grazing and the dense cover preferred by bobwhite elsewhere was limited (Tomlinson and Brown 1970; Figure 4).

In an attempt to reduce over-wintering mortality and provide nesting cover, the U. S. Fish and Wildlife Service leased 745 ha of the Las Delicias Ranch in Altar Valley from the Arizona State Land Department as a masked bobwhite release area in 1972. This lease, along with a Bureau of Land Management section on Rancho Seco between the Las Guías Mountains and Cerro Colorado were to provide nesting habitat free from grazing. However, when post-release investigation showed released birds preferred bottomlands (Brown and Ellis 1977), 465 ha of bottomland habitat on the Buenos Aires ranch in Altar Valley were leased from the Victorio Land and Cattle Company and the Las Delicias and Cerro Colorado leases were abandoned.

The first masked bobwhite from Patuxent—all pen-reared birds—had been released into the wild in 1970. Many of these birds suffered deformities due to excessive de beaking and confined rearing. After 1971, the quail were held in Tucson for three months prior to release, but it was not until 1974 that captive birds were released with

any conditioning to the wild. Most of the birds disappeared within 2 months and mortality from predation was abnormally high (Ellis and Serafin 1977). By 1978, >7000 domesticated bobwhite had been released in Arizona. Dave Ellis, a raptor biologist assigned to the project to replace the retiring Roy Tomlinson, addressed the poor condition of the birds by experimenting with several innovative conditioning techniques.

In 1974, two conditioning techniques were initiated to produce more release-worthy stock (Ellis et al. 1978). One was a modification of the foster parent – adoption methods originally described by Stoddard (1931) and Hart (1933), and later modified by Stanford (1952). The most promising foster parents proved to be wild-caught Texas bobwhite (*C. v. taylori*) males sterilized by bilateral vasectomy (Ellis and Carpenter 1981). These male birds readily adopted masked bobwhite chicks, after which both were released on the study sites. The second technique was a modification of the call-box conditioning program proposed by Hardy and McConnell (1967:29) in which released birds are called back to a predator proof pen each evening by a calling female.

These techniques were tested with thousands of released masked bobwhite between 1974 and 1979 (Brown and Ellis 1984). With both pre-release and post-release training programs in place, propagated birds were thought to be more prepared for survival in the wild. Many of the birds released in 1976 survived into the winter, and by the onset of next year's summer rains ~30 masked bobwhite remained near their release sites on the Buenos Aires ranch. The following October a pair of masked bobwhite was sighted with at least three chicks—the first documentation of over-winter survival and recruitment by propagated stock. These birds were not far removed from their wild-trapped origins, and call-count surveys in 1979 resulted in 74 calling males being recorded – an all-time record of birds present.

In 1977, the first recovery plan was drafted, approved and published. In addition to continuing the propagation techniques already developed, an emphasis was placed on studying and transplanting wild stock when sufficient birds were available (Brown and Ellis 1977). Periodic burning and food plots were recommended to improve habitat quality and reduce the mortality of released pen-reared birds, which were exhibiting high mortality during the winter months. These birds were only a generation or two removed. In the meantime, quantitative studies by Goodwin and Hungerford (1977), Reichenbacher and Mills (1984), and Simms (1989) determined that the preferred habitats of released quails consisted of bottom lands containing 10-15% woody plants, 12 to 50% grass cover, and 10 to 15% forbs.

The Nature Conservancy negotiated a contract for managing the Sonoran habitats and for conducting field studies of the Sonoran investigations that left the management of Rancho Carrizo to an agreed upon livestock grazing plan. Setting up a burning regimen proved difficult on both sides of the border, and no attempt was made to improve the quality of birds being released in Sonora. Quantity was considered more than

quality and the impact of these releases on wild birds went undocumented.

By 1979 a sizeable wild population of masked bobwhite was thought to be present on the Buenos Aires Ranch; the number of calling males had increased from 21 in 1977 to 74 in 1979 (Goodwin and Hungerford 1981). Thereafter, however, livestock grazing on the leased pastures, combined with summer drought, resulted in sharply reduced populations (Goodwin 1982, 1983). Releases were terminated when only nine birds were detected in 1982 (Levy and Levy 1984, Ough and deVos 1984). Although the feasibility of reestablishing masked bobwhite had been demonstrated, and valuable insights into the bird's habitat preferences had been obtained, the most valuable lesson learned should have been a reiteration of the bird's vulnerability to grazing and drought. A refuge managed exclusively for masked bobwhite was necessary if bobwhite were to survive in both Mexico and the U. S.

Meanwhile, conditions in Sonora were deteriorating. To evaluate the suitability of pastures that had undergone brush removal, almost 3000 pen-reared adult, immature and chick masked bobwhite had been released at three locations in Sonora, mostly between 1980 and 1982 (Brown and Ellis 1984). The success of any of these releases is doubtful, however (Mills and Reichenbacher 1982). Prospects were compromised at all 3 sites because of livestock grazing and the low quality of the birds released, none of which had received any conditioning to natural conditions.

Establishment of Buenos Aires National Wildlife Refuge

In 1985, after nearly two years of controversy and lobbying by the Audubon Society, Senator DeConcini arranged for the Buenos Aires Ranch to be purchased by the FWS as a National Wildlife Refuge for the masked bobwhite. Although reports of masked bobwhite in various parts of Altar Valley persisted, the actual presence of birds could not be verified. It thus appeared that the introduced population had died out, despite moderate and above average summer precipitation between 1981 and 1984. The hope was that the elimination of grazing would now allow new birds to survive seasons of declining population levels. A reintroduction program using the Texas bobwhite adoption technique was reinitiated in 1985 in conjunction with the total exclusion of livestock grazing (Dobrott 1990). Meanwhile, the birds persisted in fluctuating numbers on several pastures south of Benjamin Hill in Sonora, Mexico.

The late 1980s and early 1990s was a time of several investigations and some optimism. The birds in Sonora had survived 7 years of drought in the 1970s and again in the 1991-93 period, were persisting with brush control, and the introduction of "light grazing" to their habitat (Camou et al. 1998). In addition to a "short-term" cattle rotation plan, 25,000 seedlings of native shrubs had been planted in cleared areas subject to disking and shredding. Some pastures were planted in buffleggrass (*Pennisetum cilcare*) and an effort was made to encourage this plant

over brittlebush (*Encelia farinosa*). Attempts were also made to arrest the proliferation of cat-claw mimosa (*Mimosa laxiflora*) (Martin-Rivera et al. 2001). No pastures were set aside as livestock-free control areas, however, and bobwhite populations in Sonora generally declined despite average precipitation amounts (Camou et al. 1998). Surveys during the winter of 1990-91 showed 58 birds in four different areas including a new site near Las Tricheras (Las Cruces) (Garza-Salazar 1992).

The results of the land management practices initiated on Rancho El Carrizo and adjacent ranches were mixed. More than half of the woody shrubs planted perished, and no bobwhites were detected on the study plots despite "excellent" range conditions and a two-year rest from grazing (Martin-Rivera et al. 2001). Mule deer (*Odocoileus hemionus erimicus*), antelope jackrabbits (*Lepus alleni*) and javelina (*Pecari tajacu*) were said to have increased along with bufflegass. The disking and other land management practices were considered a success for both livestock management purposes and bobwhite habitat (Camou et al. 1998).

The 1990s also saw a new quail biologist on BANWR and a new masked bobwhite recovery plan (Kuvlesky and Dobrott 1995). Although some of the released domestics had demonstrated an ability to overwinter, the number was such that refuge personnel feared that a self-sustaining population could not be attained without continued releases. Based on 43 calling males and other survey data, Dobrott (1990) had estimated a population of 300-500 bobwhite on BANWR — a figure that would become the mantra of refuge personnel when asked how many masked bobwhite were present. Many of these birds failed to survive the 1990-91 and 1991-92 winters, however—a setback thought to be due to raptor predation, lack of winter food and hypothermia. The answer was more releases using the same two techniques of fostering masked bobwhite chicks to Texas males and teaming chicks with older captives conditioned to living on BANWR.

The total number of bobwhite released on BANWR from 1984 to 1994 totaled 17,438, with another 40 chicks inadvertently released in the Santa Cruz Valley in 1981. No food plots were provided and no predator control conducted.

A new management plan, which called for two self-sustaining populations in Arizona and two additional populations in Sonora, was ambitious, perhaps overly so. Among the several new management efforts recommended were research into genetic testing, annual monitoring of populations, and a search for new populations. Habitat improvements included prescribed burns, the installation of guzzlers and sprinklers, and light grazing in both Sonora and on BANWR. Also included was additional research into the bird's life history and behavior, better habitat management practices, the provision of sorghum as a food plot plant was reportedly highly successful in attracting bobwhite at Rancho Carrizo in 1991 (Camou et al. 1998), and a refuge in Mexico strictly for bobwhite. Most of these recommendations were never implemented to the prescribed degree, and the results of those that were implemented, were compromised by the release of captive

birds prior to any evaluation. A serious fault of the 1995 plan was to continue the release of captive birds rather than allowing overwintering populations to rise and fall with natural conditions.

Evaluations and Criticisms

One of the most innovative things accomplished by Kuvlesky was to have bobwhite mentor Fred Guthery evaluate the masked bobwhite recovery program. Both Guthery and Kuvlesky were "Aggies" from Texas A&M and familiar with bobwhite situations in that state. Guthery was an expert authority and knew Texas bobwhite as well as anyone.

Guthery noted that wild bobwhite in Sonora were better adapted to arid conditions than the released birds. He determined that heat as well as precipitation and humidity were important limiting factors, and that drought increased predation rates as well as reduced nesting success. The low dispersion rates of released masked bobwhite also reduced hatching rates and limited genetic diversity. He concluded that landscape change had been detrimental to bobwhite survival by expanding the distribution of woody plants, reducing the amount of grass cover, and increasing ground level temperatures. These same changes increased the bird's exposure to aerial predators, and reduced the diversity of herbaceous quail foods. He did not consider the presence of Lehmann's lovegrass (*Eragrostis lehmanni*) and bufflegass as serious detriments nor was he particularly concerned about interspecific competition— issues of concern among members of the Masked Bobwhite Recovery Team.

Guthery thought that the bobwhite's primary problem was a lack of herbaceous cover and that the conservation emphasis should be in the tropical environments in Sonora. Conscious of the Mexican government's change in emphasis from agricultural production to resource utilization, he encouraged landscape restoration rather than protection as the primary conservation need. Disking and soil aeration were encouraged as were other active landscape measures including an accelerated burning program, food plots, the provision of water, and light grazing. Although well intentioned, the inability of masked bobwhite to tolerate any removal of grass cover during times of drought would bode ill for the Sonoran populations.

In an invited analysis of the masked bobwhite recovery program, Wildlife Society personnel called for a more scientific approach to recovery (Hernández et al. 2006). Overly optimistic in its assumption that recovery was underway, this report claimed among other things that biologists had never proven that masked bobwhite were not negatively impacted by brush invasion, had always experienced low reproductive rates, and had not been impacted negatively by non-native grasses. Although some of this criticism may have had some merit, the recommendations presented in Hernandez et al. 2006 were either too late or not implemented, and were proven moot with the disappearance of wild birds shortly afterward.

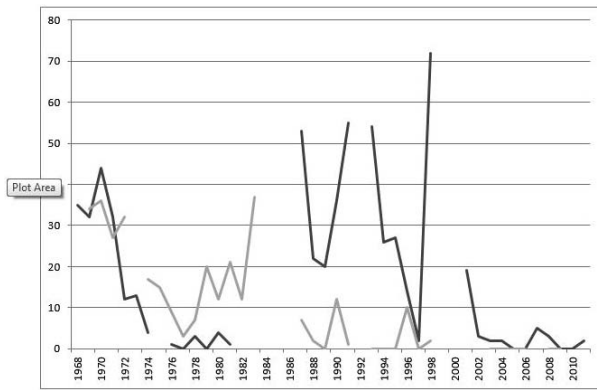


Fig. 5. Call count results from Rancho El Carrizo (dark gray) and Rancho Grande (light gray), Sonora, Mexico, 1968-2011. Data from USFWS (2014a). Gómez Limón reported the last verified masked bobwhite in Sonora as one seen and photographed in 2007. Reports since that year have not been verified.

After an uptick in the call-count surveys during the favorable year of 1999, 37 masked bobwhites were captured at Rancho El Carrizo, 25 of which were released on the central portion of BANWR (Gomez Limon 2008). Although some of these birds overwintered and reproduced based on unbanded birds being captured, captive releases were resumed the following year, both north and south of the site where the wild birds were released. This was unfortunate in that in addition to the obvious genetic problems that were becoming apparent with the captive population, these releases failed to consider the dangers posed to wild birds by the spread of such incipient diseases as respiratory cryptosporidiosis (*Cryptosporidium baileyi*) found in confined gallinaceous birds (see e.g., Baines et al. 2014). Whatever the case, no masked bobwhite were documented as being heard or seen on BANWR thereafter.

Meanwhile, few land management improvements had been undertaken in Arizona and few birds, if any, detected after the year 2000. The captive population at BANWR was plagued by disease, deformities, and inbreeding. The foster parent program was abandoned due to the threats of hybridization, disease transmission, infertile birds, and the high costs involved. All releases were terminated in 2005.

Survey Efforts: 1977 - Present

The Masked Bobwhite Recovery Plan, approved in 1977, called for annual call count surveys to be conducted to monitor both the wild population in Sonora and released birds in Arizona and Sonora (Brown and Ellis 1977). Call count surveys are generally used to develop a population index to show relative size of a population, rather than actual population numbers or density. Figure 5 shows the results of call counts conducted from 1968 to 2011 on two ranches in Sonora (data from USFWS 2014a). These results show wide variability in population levels, with isolated periods of increasing populations, such as at Rancho Grande in 1977-1983 and at Rancho El Carrizo in the late 1980's to early 1990's, interspersed with longer periods of low or declining population levels.

These results should be interpreted with caution however, as it is not clear if the same methods and survey effort were consistently utilized across years. The general correlation between the El Carrizo and Grande counts from 1968-1984 lends some credence to the utility of the data as a general index for the relative population levels in the region during those years. After 1984, however, results from the sites are highly discordant, and the brevity and variations in survey effort may obscure population trends during this period.

Extensive surveys in 1991 employing both winter covey surveys using dogs as well as summertime call counts found several new inhabited areas beyond the known Rancho El Carrizo population including areas to the west near Trincheras and to the south near Carbó (Garza-Salazar et al. 1992). Surveyors found bobwhite occurring on six separate ranches, plus reports of recent sightings by locals on three more ranches near Sásabe, Sonora. They concluded that populations seemed to have expanded in the Benjamín Hill area, but had disappeared in other areas, and was extremely small in the newly found site.

Surveys in the mid-2000's focused on censusing the population at Rancho El Carrizo and surrounding areas (Gómez Limón 2008). These surveys primarily used walking routes, where an observer would look and listen for bobwhite. Some limited vehicular surveys, as well as some call playback attempts were also made. A few searches with dogs were attempted in late winter.

The results of these later surveys compared to the 1968-1982 period at both Rancho El Carrizo and Rancho Grande show that after declines in the mid-1970's due to regional drought, population growth rises in the early 1980's, but undergoes a series of wide fluctuations in the late 1980's and 1990's before crashing in the 2000's. Camou et al. (1998) found that populations of masked bobwhite declined in 13 of 14 years when the preceding three year average of June-August rainfall was below 20 cm, and increased in 11 of 13 years when the preceding three year average was above 20 cm.

Masked bobwhite in the 21st Century

The year 1998 was characterized by record rains in the southwestern U.S. and northwestern Mexico, and masked bobwhite call counts at Rancho Carrizo reached a 30 year high (Figure 5). This boom proved to be short-lived, however, as 2002 was one of the driest years on record in the Southwest. Populations of many wildlife species crashed, including the Sonoran Pronghorn, which was reduced from 142 in 1998 to 21 individuals on the Cabeza Prieta National Wildlife Refuge in southern Arizona. Masked bobwhite fared no better, and call counts resulted in a population index near zero (Figure 5). The last confirmed sighting of a wild Masked Bobwhite anywhere was a single individual found and photographed in 2007 (Gómez Limón 2008).

Roy Tomlinson assisted in a weeklong call count survey in 2006 of the remaining habitat around Benjamin Hill. The dean of masked bobwhite field studies, Tomlinson wrote several memos comparing his observa-

tions during this survey with his experiences during his extended studies in the area in the late 1960's-early 1970's (Tomlinson 2006a, 2006b, 2006c). He criticized the lack of management for bobwhite and the overstocking of cattle "it is my impression that habitat status has declined conspicuously from the early 70's to the present. Many areas have many more trees and less grassland than before" (Tomlinson 2006b). He went on to conclude that, "I suggest that the population has been reduced to a mere fraction of that that I observed in the 1970's. It was a very discouraging result that signaled the disappearance of masked bobwhites in Sonora" (Tomlinson 2006c).

Tomlinson also lamented the lack of action on the part of U.S. conservationists to conserve any habitat for bobwhite in Mexico. He recommended completely removing cattle on select pastures that would be managed instead for mule deer hunting. He noted, "This practice would greatly benefit the quail by providing much better grass and shrub cover" (Tomlinson 2006b).

After these surveys a renewed effort by the USFWS Recovery Team led to a draft conservation plan released in 2008 (Masked Bobwhite Recovery Team 2008). This conservation plan had four goals: 1) Locate and preserve one wild, viable population of masked bobwhites in Mexico; 2) Ensure species survival through maintenance of captive programs; 3) Establish a second breeding facility in the U.S. or Mexico; and 4) prepare captive birds for release in Mexico. This document emphasized putting resources into the captive breeding program despite the first goal being the preservation of wild birds. Captive releases could not occur unless a viable population was found, and if only low numbers of wild birds were found this would necessitate releasing captive birds in areas of a remnant wild population.

Of these goals, the only one in which progress was made was in establishing an additional captive population outside of the one maintained at BANWR. By 2011, a new facility was under construction at African Safari in Puebla, Mexico (Mesta 2012). This facility is now rearing parent-reared birds for future release.

The 2008 Recovery Team Framework placed emphasis on the captive flock rather than surveys for wild birds. By 2012, USFWS refuge staff had summarized the captive breeding effort: 120 pairs bred each year with >31,000 pen-reared birds released to date of which >21,000 were released on the refuge (Cohan et al. 2012). Despite the massive time and monetary commitment to the captive flock, no wild population was ever established. Disagreement with the priorities outlined in the Recovery Team Framework led the USFWS Region 2 staff to author the *USFWS Conservation and Management of Masked Bobwhite Quail Future Direction* published in 2014. This document reinstated the expressed goal of identifying and preserving a wild population of masked bobwhite, with the captive flock reduced to serving as a safeguard against extinction (USFWS 2014b).

From 2009-2012 the authors conducted six separate survey excursions to various historical habitats in Sonora, culminating in February 2012 with a weeklong survey with dogs of the Yaqui Reservation. These lands are traditionally closed to outsiders, and we were fortunate to

be given access to an area that had looked to contain high quality habitat during aerial overflight surveys (Brown et al. 2012). We did succeed in finding high quality habitat with impressive grass cover, but could locate no bobwhite. Only small portions of a vast landscape could be surveyed in our short amount of time in the field, and follow up surveys would be worthwhile.

The USFWS has dedicated funding in 2016 to conduct systematic surveys for masked bobwhite throughout the ranches of the Benjamin Hill area. Future plans include an expanded survey over much of the historical masked bobwhite range in Sonora. Parent-reared captive-bred birds from a captive breeding facility in Puebla are being readied for release in areas deemed to contain suitable habitat and found to be devoid of wild birds.

A report released by the Office of Inspector General in January 2017, documented negligence by staff of the USFWS in caring for captive masked bobwhite and not providing suitable facilities (OIG 2017). A presentation to the Masked Bobwhite Recovery Team in October 2015 showed photographs of the poor condition of the captive birds, with injuries to beaks and feet, and missing feathers due to aggressive interactions among birds in very crowded conditions. Upon learning of the presentation, USFWS staff from the Regional Office seemed as concerned with the public relations fallout as with the condition of the birds (OIG 2017). The report emphasized the lack of communication between various offices of the USFWS, and the seeming lack of direction in the Masked Bobwhite Quail Program.

Thus, nearly 10 years after the species was last seen in the wild, the USFWS and the Masked Bobwhite Recovery Team have finally agreed to systematic surveys throughout the Benjamin Hill area, and on historically suitable habitat. The results of this effort will guide if, when, and where future releases of captive bred birds may be released.

SUMMARY OF PAST RESTORATION FAILURES

The following shortcomings have been identified in past restoration attempts keeping in mind that the restoration of any race of bobwhite may be extremely difficult.

1. There has been a general emphasis and reliance on unsuitable captive-reared birds including poorly documented releases in Mexico, the interactions of which may have threatened the survival of wild birds in addition to released wild-caught birds.
2. Diversion of funding away from studies and surveys of wild birds in Mexico in favor of a captive breeding program and the release of propagated stock.
3. Failure to follow the 1984 Recovery Plan that emphasized the release of wild-caught birds and recommended the provision of food plots to increase over winter survival rates
4. The organizational structure of the U. S. Fish and Wildlife that lead to no clear command of the masked

bobwhite recovery program, the hiring of personnel, and the selection of recovery team members who were chosen not for their experience and knowledge, but to represent participating agencies.

5. Poor public relations due to poor administrative actions as not paying the travel of some but not all experts, and a lack of volunteer effort by BANWR personnel.
6. A general lack of research and natural history studies, especially of birds in Mexico
7. A haphazard monitoring of birds in both Arizona and Sonora
8. A lack of coordination and participation by Sonoran biologists, officials in CEDES, and Mexican universities.
9. Reluctance to engage volunteer bobwhite experts to find additional populations in Sonora and comment on recovery operations.

RECOMMENDATIONS

Some hope remains. A renewed emphasis on surveying wild populations of bobwhite in Mexico is under discussion, and should be implemented. Western Mexico encompasses a large area and much of it has never been surveyed for masked bobwhite. In addition, should a wild population be found, a significant area of suitable habitat should be purchased and managed for bobwhite free of livestock grazing. Excess numbers of wild-trapped birds in good years could then be used to restock historic habitats in Altar Valley and along the Santa Cruz River, which after > 30 years of rest have now had sufficient time to recover from the rigors of grazing during drought. That the characteristics of masked bobwhite habitats have been identified and are available for analysis should aid in this effort (Brown et al. 2012).

Given that bobwhite are extremely difficult birds to restore and suitable stock may no longer be available, the use of surrogate taxa should be considered. As early as 1887 Brewster recognized that *C. v. coyvolcos* closely resembles *C. v. ridgwayi* and that the two spp. are nearly identical. If genetic analysis shows this subspecies or another subtropical race of bobwhite is closely related to the masked bobwhite, wild trapped birds of this taxon could provide suitable surrogates for restoration in historical habitats in Arizona. Efforts to determine these relationships are currently underway.

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