Western Quail Management Plan

Wildlife
Management
Institute

November 2009

Western Quail Management Plan

Association of Fish & Wildlife Agencies
Resident Game Bird Working Group

Senior Authors
Mark Zornes, Arizona Game and Fish Department
Richard A. Bishop

Bird Conservation Region Authors
Dave Budeau, Oregon Department of Fish and Wildlife
Don Kemner, Idaho Fish and Game Department
Tom Blankinship, California Fish and Game Department
Dennis Southerland, Utah Division of Wildlife Resources
Mary Hunnicutt, U.S. Fish and Wildlife Service
Shawn Espinosa, Nevada Department of Wildlife
Doug Schoeling, Oklahoma Department of Wildlife Conservation
Ed Gorman, Colorado Division of Wildlife
Mick Cope, Washington Department of Fish and Wildlife
Robert Perez, Texas Parks and Wildlife Department
Mick Mitchener, Kansas Department and Parks
Larry Kamees, New Mexico Game and Fish Department

Publication Management by Scot Williamson, Wildlife Management Institute

Montezuma Quail Chicks in Washington/Lisa Cross

Cite as:
Zornes, M, and R. A. Bishop. 2009. Western Quail Conservation Plan. Association of Fish and Wildlife Agencies. Washington, DC. 92 pages.

Acknowledgments

A continent wide effort of this magnitude would not have been possible without the assistance of many dedicated professionals. The authors appreciate the leadership of John Frampton and Breck Carmichael, chairs of the Resident Game Bird Working Group of the Association of Fish and Wildlife Agencies. We thank the directors of the Western Association of Fish and Wildlife Agencies for the support and staff time obligated to produce this conservation plan; without their support and without the leadership of the Arizona Game and Fish Department, the completion of this plan would not have been possible. We would also like to thank Dick Haldeman, Dale Rollins, Sanford Schemnitz, Doug Lynn, Mike Rabe, Ron Day, Tom Waddell, Amy Krause, Bill Merhege, Geoffrey Walsh, Michael Eberle, John S. Sherman, Danielle Flynn, James Levy, Seymour Levy, Gail Tunberg, Dwight Fielder, Terry Riley, Robert Davison, Len Carpenter, Don McKenzie, Richard McCabe and many others who provided reviews and shared their knowledge and guidance in completing the *Western Quail Management Plan*. Special thanks to Duane Shroufe, Executive Director of the Arizona Game and Fish Department, for his leadership and guidance and to Rick Horton who created the BCR maps.

Financial support for the development and delivery of the Western Quail Conservation Plan was provided by the National Fish and Wildlife Foundation, the Bass Foundation, state fish and wildlife agencies, and the Wildlife Management Institute. The Arizona Game and Fish Department provided financial assistance towards publication costs.

Front cover photo credits clockwise from upper left: Gambel's Quails in Arizona/AGFD; Scaled Quail in New Mexico/NMDG&F; Masked Bobwhite in Arizona/Mary Hunnicutt; California Quail in California/Christopher Russell; Montezuma Quail in Arizona/AGFD; Mountain Quail in Oregon/ Richard Vetter. Back Cover: Desert habitat/Larry Kruckenberg.

Desert habitat/Larry Kruckenberg

Contents

Montezuma Quail in Oregon/Richard Vetter

Gambel's Quail brood habitat in New Mexico /Larry Kamees, NMDGF

Executive Summary

Mountain Quail on nest in Oregon/Richard Vetter

The Western Quail Conservation Plan was created to provide range-wide and Bird Conservation Region (BCR) assessments of western quail population size, habitat abundance, current threats, management recommendations and research needs. The six species of western quail included in the plan are California quail, scaled quail, Montezuma quail, mountain quail and masked bobwhite. While a seventh quail species is present in the West, the bobwhite, it is excluded from this plan because of the recent publication of the Northern Bobwhite Conservation Plan.

Five of the six species of western quail included in the Plan are fairly abundant gamebirds. The sixth species, Masked Bobwhite, is a federally listed endangered species and occupies only a fragment of its former range.

Western quail occupy habitats from the shrublands of northwestern United States to the deserts of the Southwest. Throughout the ranges of the various species, quail abundance is a product of habitat availability and quality, and by extension, patterns and timing of rainfall. Habitat conditions and population densities were based on available data or the expertise of resource professionals knowledgeable of regional conditions and populations. Because comparable population estimates for each BCR were not available, harvest estimates were used to index population size. No Plan is complete without suggesting how to advance the conservation status of the species and management recommendations are included within each of the BCR descriptions and for the entire region.

In general, western quail populations reflect long term changes in habitat condition. In some BCRs, quail populations are in long term decline because of changes in land use. In other BCRs, quail populations are stable, but can be increased with appropriate management of habitats, especially when focused on enhancement of a diversity of native shrubs and herbaceous plants.

Management recommendations differ to reflect the different species and different landscapes occupied, but there are commonalities. Public land agencies can embrace the conservation of native quail by stepping down management recommendations from the Plan to establish specific management recommendations for land management unit plans. Habitat improvement in many locations may be obtained by balancing the level of livestock grazing to ensure benefits to quail by

enhanced grassland and shrubland condition. Management to provide periodic disturbance is critical to some species. Control of invasive plants and promotion of diverse, native shrublands is essential throughout for all species. Recommendations for management of water distribution include enhancement of riparian areas and restoration of springs and seeps and, in some locales, construction of artificial water sources. Since reports of harvest index population change, improved surveys of harvest to produce comparable statistics between states and regions is critical to further assessments of quail conservation.

Recommendations for research topics to improve the manager's knowledge of quail population dynamics are provided. As quail occupy some of the most arid regions of the U.S., responses of western quail to climate change and projected decreases in precipitation and increases in temperature need to be understood better.

The Plan provides a benchmark for continued conservation of western quail. Updates to the Plan will be based on consistent assessment of population change and comparable tracking of management recommendartions.

Quail hunting in New Mexico/Mark Gruber, NMDGF

As quail occupy some of the most arid regions of the U.S., responses of western quail to climate change and projected decreases in precipitation and increases in temperature need to be understood better.

Introduction

Lower Cascades, Mountain Quail habitat/Michael Pope

The *Western Quail Management Plan* (Plan) has been developed under the auspices of the Resident Game Bird Working Group of the Association of Fish and Wildlife Agencies. The development of the Plan is part of a continuing effort to establish species-specific or species-group-specific conservation strategies to guide resource planning and on-the-ground habitat management initiatives.

The Plan utilizes the North American Bird Conservation Initiative's bird conservation regions (BCRs) as the geographic assessment unit to ensure consistency with other planning efforts that focus on avian species. BCR boundaries may be viewed at http://www.nabci-us.org/bcrs.html. Assessments are provided for those BCRs which represent the core range of western quail in the United States.

Species included in the list of western quail include California quail, Gambel's quail, scaled quail, Montezuma quail, mountain quail and masked bobwhite (Scientific names of plants and animals mentioned in the text are listed in Appendix A). While there are populations of northern bobwhite residing in some of the BCRs included in the Plan, northern bobwhite management needs were not included because of the existence of the Northern Bobwhite Conservation Plan.

The geographic coverage of the Plan is limited to the United States portions of the range of western quail. Assessments of western quail populations in Mexico and Canada are not included in the Plan.

The primary objectives of the Plan are to provide indices of population and habitat and to assemble current assessments of threats, management recommendations and research needs. Habitat conditions and population densities were based on available data or the expertise of resource professionals knowledgeable of regional conditions and populations. Because comparable population estimates for each BCR were not available, harvest estimates were used to index population size. Also, western quail population size is frequently more dependent on variable, localized, rainfall patterns than habitat quality or quantity.

The Plan is organized to describe the natural history of each of the six species of western quail. Assessments and management recommendations are then included within each of the BCR descriptions.

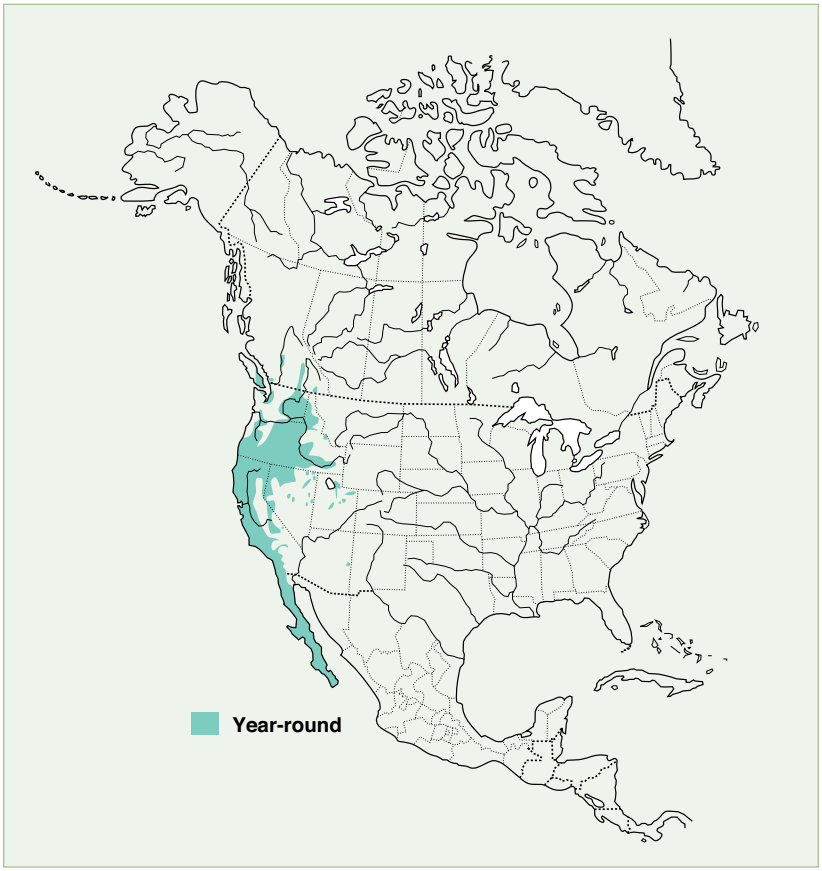
Descriptions of
Western Quail Species

California Quail

Description

The California quail is a medium-sized quail. Weights of specimens taken from various portions of their original range average from 5.3 to 6.7 ounces (150.6–189.5 g), with the largest occurring in northern California and the smallest in lower Baja California (Sumner 1935). Leopold (1977) recognized seven subspecies, one of which (C. c. catalinensis) is thought to have resulted from translocations of quail from the mainland of California to Catalina Island by humans 12,000 years ago (Johnson 1972).

Males are slightly greater in length than females (10.2 to 10.6 inches (260–270 mm) compared with 9.5 to 10.5 inches (241–266 mm) for the specimens reported in Grinnell et al. (1918). The sexes are distinct in color. The male is colorful and has a black throat circled with a white line. The top of the male's head is dark brown, with a plume of black curved feathers. The male's breast is gray, the sides and flanks are streaked with white, and the rest of the underparts have dark and light scaling; there is a red-brown patch at the center of the belly. Females are mainly brown with a scaled breast and have streaked flanks similar to the male. The plume is not as distinct as the male's. Young birds can be distinguished from adults in the fall and winter by the greater upper primary coverts on the wings. These feathers are tipped with buff color and are more pointed in birds-of-the-year; they are solid gray with rounded tips in adults.



The California quail's plumage is distinct from that of all other North American quail, except for Gambel's quail. Male Gambel's quail have a black patch on an unscaled belly, and the top of the male's head is rust-red.

Natural History

Reproduction

California quail typically are monogamous. Coveys tend to break up in March; males display aggressive behavior toward each other, and pairs form within about two months. It is common for adult birds to form pairs earlier than birds-of-the-year, and adults typically mate with other adults (Genelly 1955). Egg laying begins in early April in

California Quail habitat/Don Kemner

southern California, in late April in central California, and in late May or early June in northern California and the Great Basin (Leopold 1977). In western Oregon, hatching dates ranged from late May through mid-September with peak hatch occurring during the first part of July (Crawford 1986a). The incubation period is between 22 and 23 days.

Nest locations. Glading (1938) reported finding 93 nests during 1937 at a study site in central California on the western slope of the Sierra Nevada. Fifty of those nests were in dry grass or weeds, and the others were in rock piles, gullies or at the base of shrubs. In western Oregon, 24 of 50 nests were located in shrub-grassland (Kilbride et al. 1992).

Clutch size and nest success. Glading (1938) found that, of 40 nests that reached the stage of incubation, average clutch size was 11. Of the 93 nests observed by Glading (1938), 17 successfully hatched.

Renesting and double brooding. If a nest is destroyed before hatching, California quail may nest a second or third time. Successful renesting attempts will result in broods hatching later; these will be smaller than broods from initial nesting efforts in the same location, which may erroneously be taken as evidence of double-brooding. However, under favorable conditions, California quail may indeed raise two broods, with males playing a significant role in brood rearing (Leopold 1977). Conversely, in the most arid portions of their range, they may not breed at all in extremely dry years (Leopold 1977).

Mortality and Survival

Fluctuations in age ratios. California quail populations typically exhibit high mortality and may fluctuate considerably over time. In an extensive study from 1950 to 1957, at a100-acre (40.5 ha) site near Berkeley, California, Raitt and Genelly (1964) found that the average rate of annual mortality was more than 70 percent. Age ratios in the fall varied from 56.5 immatures per 100 adults to 222 immatures per 100 adults. McMillan (1964) reported age ratios of 15,166 California quail shot during 25 hunting seasons near Shandon in San Luis Obispo County, California. Immatures per 100 adults varied from 4 to 430. Leopold (1977) also summarized age ratios and rates of population turnover reported from other parts of the bird's range for studies of at least 4 years duration. Although not as dramatic as the variation reported by McMillan (1964), all show substantial changes in ratios of immatures to adults, with average population turnover (replacement) rates between 63 and 77 percent.

Effects of weather on reproduction. It is generally accepted that the dramatic changes in ratios of immature to adult California quail result from differences in weather

patterns. Francis (1970) compared the effects of weather during 14 years on age ratios of quail taken at the study site near Shandon, California, mentioned above. He found that, in order of importance, quail productivity seemed to be a function of: (1) soil moisture in late April, (2) proportion of breeding females more than one year old and (3) the seasonal rainfall from September through April.

In a discussion of regional characteristics of the range of California quail, Leopold (1977) stated that years of high rainfall are favorable for quail production in arid ranges; annual changes in precipitation are less important in the foothills surrounding the Sacramento Valley; dry years are favorable and wet years unfavorable for production in humid forest ranges; in Great Basin ranges, warm, dry springs are favorable while wet, cold springs are unfavorable.

Sex ratios. The proportion of males to females in the first few months of life is approximately even and shift to a higher proportion of males in adult birds. Raitt and Genelly (1964) found a ratio of 145 males to 100 females in birds that had gone through at least one breeding season. Similar results are described from other states (Leopold 1977). Males also outnumbered females in Oregon, but a disparity in ratios was noted between samples obtained by trapping (1.1 males/female) and shooting (1.6 males/female) (Crawford and Oates 1986).

Predation. Cooper's hawks are thought to be a key predator because they often have been observed attempting to take quail, sometimes successfully. They have taken quail caught in traps set by researchers. However, there is little quantitative information indicating that Cooper's hawks have a major effect on quail populations. Leopold (1977) reported that 18 Cooper's hawks were taken at a study site near Shandon, California, in an area of high quail population. Two contained the remains of quail. Similarly, stomachs of only 3 of 25 Cooper's hawks examined during a study in San Luis Obispo County, California, contained quail (Glading et al. 1945).

Northern harriers tend to frequent open grasslands, rather than areas commonly used by quail. However, where their ranges overlap, northern harriers may take some quail. Glading et al. (1945) reported that 20 percent of all items brought to nests of northern harriers in his study site in San Luis Obispo County were young California quail. Predation by other raptors has been reported but appears not to be of much significance.

Bobcats are a mammalian predator sometimes mentioned in the quail literature but, in studies where stomach contents of bobcats are reported, quail remains were found in only a small proportion. Sumner (1935) reported that 3 percent of 156 bobcat stomachs from California contained quail. Leach and Frasier (1953) looked at stomach contents from 53 bobcats taken in the vicinity of quail watering devices where quail were common. Only one of these bobcats contained the remains of quail.

California quail populations typically exhibit high mortality and may fluctuate considerably over time. In an extensive study from 1950 to 1957, at a100-acre (40.5 ha) site near Berkeley, California, Raitt and Genelly (1964) found that the average rate of annual mortality was more than 70 percent.

California quail are highly dependent on protective, brushy escape cover. In some of their range, such as the western Sierra Nevada foothills, rimrock country of northern California, eastern Oregon, Washington and along the Snake River in Idaho, rocky outcrops provide escape cover.

Numerous other predators, such as red-tailed hawks, prairie falcons, kestrels, coyotes and long-tailed weasels are known to take quail occasionally but not in large numbers (Leopold 1977). Nest predation actually may be more significant than predation on the birds themselves. In a study reported by Glading (1938) in central California, of 93 nests, 54 were destroyed. Of these, 30 were destroyed by Beechey ground squirrels; other nest predators were house cats, coyotes, skunks, scrub jays and gray foxes.

Disease. Little information exists about disease in California quail and the effect of disease on quail populations. Crawford (1986b) reported the occurrence of avian pox in California quail populations in western Oregon with an infection rate of 26 percent of 256 quail sampled at one location. No deaths of quail were directly attributed to avian pox, but Crawford suggested that birds may be more vulnerable to predation of their locomotion was impaired by the infection. Leopold (1977) stated that, all in all, parasites and disease are not an important source of mortality in wild populations of California quail. The potential impact of West Nile Virus is unknown.

Home Range and Movement

California quail are typically less migratory than mountain quail. Emlen (1939) reported on home ranges in the winter of four coveys in the Central Valley of California. He found that these coveys had a home range of 19.0, 22.0, 17.1 and 45.0 acres (7.7, 8.9, 6.9 and 18.2 ha). In arid portions of their range, they may be dependent on limited water sources during the summer and fall, but this is no longer the case once fall rains begin. Measured daily movements varied from a range of 0.5 to 0.7 mile per day (0.8–1.2 km/day) in semiarid rangeland, to more than 1.0 mile per day (1.6 km/day) in areas of ample water (MacGregor 1953). A study of movements of California quail in Modoc County, California was reported by Savage (1974); 1,889 quail were banded between 1966 and 1972. He found that movements within 5 miles (8 km) of trap locations were common; maximum movement was 11 miles (17.7 km). Mean home range size of radio-marked female quail in western Oregon ranged from 9.9 to 54.4 acres (4–22 ha) (Kilbride 1991).

California quail are highly dependent on protective, brushy escape cover. In some of their range, such as the western Sierra Nevada foothills, rimrock country of northern California, eastern Oregon, Washington and along the Snake River in Idaho, rocky outcrops provide escape cover. In addition to escape cover, these birds require an intermixture of open feeding areas and dependable water sources. They are found primarily in chaparral, sagebrush scrub, oak-grassland, riparian and foothill woodland, and disturbed areas with humid forest ranges (Calkins et al. 1999).

Diet and Nutrition

Water requirements. Leopold (1977) provided an extensive review of information regarding the need of California quail for water. In general, free water is little used throughout much of the year but is critical in the summer and fall, before winter rains begin and while young quail exist. During hot, dry weather, California quail typically come to water each day. Adults with broods often visit water sources after a morning feeding period. Young broods probably do not travel farther than about 0.25 mile (0.4 km) to water, but this distance increases as they get older (Leopold 1977).

In efforts to expand the range of quail, self-filling, water-collecting devices have been installed in arid ranges. In California, more than 2,000 of these devices have been built, and, in some cases, they have increased quail numbers.

Diet. Studies of the diet of California quail have found that plant food makes up the vast majority of their diet. Leopold (1977) reported an analysis of crop contents of 2,525 California quail collected at a number of locations in California. He found that they depend largely on seeds of a large variety of broad-leafed annuals during much of the year. Examples of important food plants from California are lupine, lotus, filaree, clover, bur clover, and fiddleneck. California quail also make use of acorns, waste grain, and fruits and berries, as well as seeds of shrubs, such as manzanita, redberry, buckbrush, poison oak and California buckwheat. Leopold (1977) also found that invertebrates constitute between 1 and 6 percent of the diet and generally are taken in the spring and summer months. Prior to three weeks of age, California quail consume significant amounts of invertebrates. By 16 weeks, their diet is very similar to that of adults. During spring, a high proportion (about 35 percent of the diet) of green leafage is consumed, consisting mostly of the tender leaves of clovers, filarees and grass. Legumes were particularly important in the annual diet of California quail in western Oregon, where they accounted for 67 percent of the dry mass of quail crops (Crawford 1993).

Newman (1978) examined crops of 260 young-of-the-year California quail in Madera County, California. Vegetation at the study site was predominantly annual grassland and oak woodland. He found that seeds of herbaceous plants, nearly all annuals, composed 89.2 percent of the diet of young quail during June through October. Seeds of legumes composed 38 percent of the diet. Insect fragments composed 5.5 percent. During the study period (June-October), grass seeds, seeds and fruits of shrubs, acorn fragments, and green leafage were of minor importance.

Prior to three weeks of age, California quail consume significant amounts of invertebrates. By 16 weeks, their diet is very similar to that of adults. During spring, a high proportion (about 35 percent of the diet) of green leafage is consumed, consisting mostly of the tender leaves of clovers, filarees and grass. Legumes were particularly important in the annual diet of California quail in western Oregon, where they accounted for 67 percent of the dry mass of quail crops.

In western Oregon, at the E.E. Wilson Wildlife Area near Corvallis, Blakely et al. (1988) found that invertebrates were present in the crops of quail at all seasons, and they increased in frequency from fall through summer. Blakely et al. (1988) found that many of the key invertebrates (ants, beetles, true bugs, grasshoppers) consumed by quail in the arid portions of their range, as reported by others, also were the primary invertebrates in the diet in western Oregon. Invertebrates made up a relatively small portion of the diet, similar to what was reported from other locations, but were consumed in higher frequencies and more consistently throughout the year than in other portions of the range.

Distribution and Abundance

Original Distribution

Leopold (1977) provided an extensive discussion of the distribution of California quail. Their ancestral range extended nearly 1,300 miles (2,092 km) from north to south, and 300 miles (483 km) from east to west. They originally occurred in virtually all of Baja California (Mexico) and California, except the Colorado and eastern Mojave deserts and the higher reaches of the Sierra Nevada and Cascades. They also were originally found in a small portion of northwestern Nevada and a portion of southwestern Oregon.

Leopold (1977) argued that quail numbers reached a peak in California during the period of about 1860 to 1895. He believed that this was caused by a fortuitous combination of grazing at a level that broke up native bunchgrass and that allowed an invasion of seed-bearing Mediterranean forbs, such as filaree and clovers, and a modest level of farming.

Current Range

California quail still occupy the majority of their original range, and translocations have greatly expanded the range in the western United States, particularly in the Great Basin area. They now occur in much of eastern and in portions of western Washington, western Nevada, most of Oregon, western Idaho, and in scattered locations in British Columbia, Utah and eastern Nevada. The introductions occurred surprisingly early, beginning in the 1860s (Leopold 1977, Calkins et al. 1999). California quail were also introduced to Arizona and a small population occurs in the northeastern part of the state. Regarding what originally prohibited the spread of California quail to areas of the western United States that they now occupy, Leopold suggested that the clearing of forests and the introduction of grain crops, annual weeds, livestock feed lots and irrigated farm land created favorable habitat.

Past Abundance

Leopold (1977) provided a substantial amount of information regarding the original abundance of California quail, including records of their use by Native Americans. These birds were sufficiently abundant to be an important food item for many native tribes throughout what is now California, and a variety of techniques were developed to trap, snare and net them. It was customary that at least some of the captured quail were dried and stored for later use. As previously noted, they were even thought to have been introduced on Catalina Island, off the coast of southern California, perhaps 12,000 years ago.

Leopold (1977) also cited numerous accounts of commercial quail hunting in California in the late 19th century. Market hunters trapped many thousands of quail, some maintaining a string of as many as 50 traps. According to one account, 177,000 quail were sold in markets in Los Angeles and San Francisco during the quail-shooting season of 1895 to 1896. According to another account, two market hunters secured 300 dozen quail in 17 days in 1883 in Los Angeles and San Bernardino counties.

Leopold (1977) argued that quail numbers reached a peak in California during the period of about 1860 to 1895. He believed that this was caused by a fortuitous combination of grazing at a level that broke up native bunchgrass and that allowed an invasion of seed-bearing Mediterranean forbs, such as filaree and clovers, and a modest level of farming. This low-intensity farming in the late 1800s on soils not yet depleted of their virgin fertility was advantageous to quail. Leopold compared this situation with the peak period of bobwhite quail production in the Midwest. As agriculture became more intensive in California, habitat values for quail decreased in the valleys where farming occurs.

Reported Densities

Reported densities of California quail vary considerably. Emlen (1939) found that four coveys studied near Davis (Yolo County), California, used winter areas of 21.0 to 45.0 acres (8.5–18.2 ha) each. Calkins et al. (1999) summarize reports of densities ranging from fewer than or equal to 0.009 birds per acre (0.023 birds/ha) to more than or equal to 0.202 per acre (0.500 birds/ha). Extensive census work by Glading (1941) at a study site in Madera County, California, resulted in estimates of 0.26 to 0.59 birds per acre (0.64 to 1.46/ha). (Glading's study site was thought to be in an area of particularly productive habitat.) In western Oregon, California quail density was estimated at one bird per 13.36 acres (5 ha) on one study site (Kilbride 1991).

Covey sizes for California quail tend to be from 30 to 70 under typical conditions but may be as high as several hundred (Leopold 1977).

Abundance Relative to Rainfall and Land Use

Abundance of California quail at a specific location often varies dramatically in response to weather patterns (see "Mortality and Survival" previously). This is particularly the case in arid portions of their range, where production of young greatly increases following wet years.

Abundance also can be affected dramatically by land-use changes. Appropriate levels of grazing, adequate sources of drinking water during summer and fall, avoidance of "clean" farming that leaves no cover, maintenance of adequate brushy cover for escape from predators and for roosting, appropriate management of fire and logging, and disking to provide open habitat and to promote the growth of preferred foods all have been shown to have the potential to increase numbers of California quail (Sumner 1935, Emlen and Glading 1945, Bauer 1977, Leopold 1977, Fitzhugh 1983, Oates and Crawford 1983, and Stinnett and Klebenow 1986).

Legal Status and Harvest

California quail are a popular game bird in all states within their range: California, Oregon, Washington, Nevada, Idaho and Utah. Daily bag limits are 10 in California, Oregon, Washington, Idaho and Nevada, and 5 in Utah.

Gambel's Quail

Description

Gambel's quail are sexually dimorphic, but both sexes possess a topknot or plume consisting of approximately six teardrop shaped feathers. Males have black faces bordered in white, a chestnut crown, black topknot, gray back, buff breast, cinnamon streaked flanks and a black circular or horseshoe shaped abdomen patch. Females

are duller, with gray head and topknot, gray body plumage with buff-white tips and similarly cinnamon streaked flanks. Due to buff plumage tips, female body plumage appears browner than that of males. Males average between 6.0 and 7.1 ounces (170–200 g) (Brown et al. 1998), while females typically are between 5.6 and 6.0 ounces (160–170 g). Total length averages 9.8 inches (249 mm). Young of the year can be differentiated from adults by light-tipped and mottled upper primary coverts in juveniles versus uniform gray upper primary coverts in adults. Juveniles retain primaries P9 and P10 through their first year.

Natural History

Gambel's quail abundance is inextricably linked to winter (October-April) precipitation (MacGregor and Inlay 1951, Swank and Gallizioli 1954, Campbell et al. 1973, Brown 1989, Brown et al. 1998) and the green vegetation produced during wet years. Swank and Gallizioli (1954) reported that 90 percent of variations in annual harvest is attributed to weather-dependent nesting success.

Reproduction

Pair formation in Gambel's quail follows winter aggregate covey break-up. Males leave winter coveys first and begin seeking females in other coveys (Brown et al. 1998). Pairing typically occurs during March, but it may occur in February or earlier during good years. Older, heavier females tend to form pair bonds earlier than young ones (Brown et al. 1998). Juvenile birds form pair bonds during their first winter and breed the following spring, later than adults (Gullion 1960, Raitt and Ohmart 1966). Vitamin A reserves in the liver, obtained from green vegetation produced by winter rains, stimulates reproductive organ development and positively influences reproductive success in this species (Hungerford 1960; Hungerford 1964). Reproductive organs in females may show no development following cold or dry winters (MacGregor and Inlay 1951). Low precipitation during winter and corresponding low reproductive success may be mitigated by riparian areas and

irrigated croplands (Brown et al. 1998). Nests typically are made on the ground and are sparsely lined with leaves, grass stems and feathers (Gorsuch 1934) but they may occur in shrubs, cacti, or trees if a suitable platform is located (Brown et al. 1998). Some nests are completely shadowed by a guard object, such as a shrub, fallen limbs, a wood rat's nest, discarded lumber, tires and appliances; others are totally exposed. Egg laying can begin as early as mid-February and extend as late as mid-August. The peak occurs between mid-April and late May. Incubation of eggs averages between 21 and 23 days for this species (Brown et al. 1998). First broods appear as early as mid- to late March, with peak hatch during late April to mid-June. Clutch size has been reported to range from 5 to more than 15 eggs, with 10 to 12 being the norm (Brown et al. 1998). Nests in excess of 15 are typically considered "dump nests" (Brown et al. 1998:14). However, Hensley (1959) reported broods of 20 young. Additionally, a nest of 22 eggs was located in Maricopa County, Arizona, in 2005, which was actively incubated to complete hatch (M. Zorne personal communication:, 2007). Average brood size has been reported as nine in a New Mexico population of Gambel's quail. Broods hatched prior to mean hatch date tend to be larger (Brown et al. 1998). While evidence is anecdotal, this species may produce multiple broods during the right climatic conditions, possibly through polyandrous behavior (Gullion 1956, Brown et al. 1998) or through brood weaning at an early age, as described by Gullion (1956). One or both behaviors may have occurred under abnormally favorable conditions in Arizona in 2005. While this has been reported to contribute little to most populations (Gorsuch 1934, Senteney 1957, Hungerford 1960, Brown 1998), observations

Gambel's Quail habitat/AGFD

by Gullion (1956) and from Arizona in 2005 seem to contradict this conclusion. Wing data from a sample of 2,680 wings collected in Arizona during the 2005 hunting season suggest two peak median hatch dates: April 9 and June 19 (Arizona Game and Fish Department, unpublished data, 2005). The second peak represented nearly 50 percent of the initial peak. Multiple brooding, however, occurs only under optimum conditions.

Home Range and Movement

Home range for Gambel's quail coveys is relatively small, as are annual movements. Home range has been reported to vary from 19.8 to 94.0 acres (8–38 ha) (Brown et al. 1998). Maximum yearly movement of coveys has been reported to be fewer than 1.2 miles (2 km) (Greenwalt 1955, Gullion 1962), although, individuals may travel greater distances. Sharp et al. (1999) reported maximum movement of radio-marked male and female Gambel's quail in Nevada of 2.5 miles (6.6 km) and 4.2 miles (6.8 km),

Gambel's Quail habitat

respectively. Twenty-two percent of their instrumented birds displayed movements more than 1.9 miles (3 km).

Mortality and Survival

Mortality and survival rates for this species are primarily driven by annual variations in precipitation. Gambel's quail tend to be most abundant during wet years and less abundant during periods of drought. Timing of annual precipitation is of particular importance.

Gambel's quail are taken by numerous predators, including humans and raptors. Introduced bullfrogs have been known to take chicks at water sources (Brown et al. 1998). Chicks and eggs are likely the prey items of many species including roadrunners, cotton rats, ground squirrels, snakes and ants. While popular lore indicates otherwise, Gila monsters appear to be an infrequent nest predator of this species.

Few diseases appear to play a large role in population regulation, with the possible exception of quail malaria. This disease is not always fatal but may lead to local declines during periods of drought or poor habitat condition (Brown et al. 1998). Birds are susceptible to trichomoniasis, especially during years when birds are concentrated at limited water sources. They are commonly infected with various intestinal parasites, including nematodes and platyhelminthes. Intestinal coccidia has been documented in this species under captive situations but likely has no impact on wild populations (Brown et al. 1998).

Annual brood size and survival are quite variable In this species, and both are greatly influenced by climate, both pre- and posthatch (Brown 1989, Brown et al. 1998, Heffelfinger et al. 1999). Adult mortality averages around 40 percent annually, with higher rates of juvenile mortality. Survival for both adults and young has been estimated to be as low as 10 percent during very poor years (Gallizioli 1965). Gambel's quail chicks born during wet years with abundant green vegetation tend to have higher survival rates than those born during dry years (Sowls 1960). The percentage of juveniles in the population collected during fall hunting seasons varies from less than 10 percent during low harvest years to more than 80 percent at peak harvest.

Habitat Requirements

Gambel's quail are typically associated with brushy and thorny vegetation in the Sonoran, Chihuahuan and Mohave deserts, especially in brush-lined drainages, mountain foothills and grassy plateaus possessing a diverse shrub community. Gambel's quail range generally overlaps that of the western honey mesquite, on which it partially relies for

food and roosting cover. Although the ranges of Gambel's quail and honey mesquite do overlap to a great degree, it is likely this occurs because optimum conditions are found for both species in the same area (Brown 1989). Riparian areas become increasingly important on the fringes of this species' range (Brown et al. 1998). In the core of this species' range, Gambel's quail are partial to wolfberry or desert thorn, desert or spiny hackberry, Fremont barberry, shrub live oak, and catclaw acacia as roosting and loafing cover. Other shrubs, such as little-leaf sumac in New Mexico, become more important in the eastern parts of this species' range. Shrubs are important for heat regulation because of the shade and cover they provide. They often are associated with various mixed desert shrub and cactus in the upland subdivision of the Sonoran Desert (Brown et al. 1998). Brushier areas of the Mojave Desert receive the greatest precipitation, as do shrublands and brushy drainages in the Chihuahuan Desert, but the bird is uncommon in areas that are dominated by creosote bush. In fringe habitats, including the lower Gila and Colorado River drainages, saltcedar, saltbushes and screwbean mesquite are important Gambel's quail habitat components.

Food Requirements

Gambel's quail are primarily herbivorous, but animal matter is seasonally important, especially for growing young (Gorsuch 1934, Brown et al 1998, Medina 2003). Gambel's quail diets vary considerably throughout the species' range but generally consist of seeds gleaned from forbs, grass, shrubs, trees and cacti (Gorsuch 1934, Hungerford 1962, Brown et al. 1998, Medina 2003). Seeds from legumes are important throughout the species' range. Fruits from shrubs and cacti (particularly)) are used heavily seasonally. As mentioned previously, green vegetation, especially deer vetches and filaree, is very important during winter and early spring prior to reproduction; it provides much of the species' moisture requirements (Hungerford 1962). Mesquite seeds and leaves, jojoba seeds, tansy mustards, ragweeds and a host of other seed producing shrubs and forbs are eaten if available. For a more thorough discussion of this subject, see Brown et al. (1998).

Water Requirements

Views about water needs for this species are controversial (Gallizioli and Webb 1961) -- either the species derives water from succulent green feed (Hungerford 1960) or free water is a necessary regular requirement. Both hypothesis may be valid depending upon annual variation in precipitation patterns and location. Most studies that suggest free water is necessary on the fringe of this species' range, where conditions tend to be harsher (Gullion and Gullion 1964). Studies done in the core of this species range in Arizona show no benefit from addition of free water (gallinaceous guzzlers), and

Gambel's quail are typically associated with brushy and thorny vegetation in the Sonoran, Chihuahuan and Mohave deserts, especially in brush-lined drainages, mountain foothills and grassy plateaus possessing a diverse shrub community. Gambel's quail range generally overlaps that of the western honey mesquite, on which it partially relies for food and roosting cover.

provision of free water may artificially concentrate birds to their detriment (Smith and Gallizioli 1963). Gambel's quail use free water if available.

Distribution and Abundance

Gambel's quail are the only quail endemic to the Sonoran Desert (Brown 1989) with distribution centered in Arizona and northwestern Sonora, Mexico (Brown et al. 1998). They are also found in southeastern California, southern Nevada, southern Utah along the San Juan and Colorado River drainages, western Colorado along the Colorado and Gunnison river drainages, southwestern and central New Mexico, and along the lower Pecos River and San Juan Valleys. They also occur along the Rio Grande Valley of Texas, downstream to Presidio County. Birds have been widely introduced to nonnative range, including to portions of Colorado, California and Idaho.

Gambel's quail are the most numerous quail species within their native range. During "boom" years they can be one of the most numerous of any avian species in the Sonoran and in portions of the Mojave Desert. Abundance estimates of any gallinaceous bird are difficult to assess but density estimates for Gambel's quail range from a low of 0.11 per acre (0.27 birds/ha) (Hensley 1954, Gallizioli 1965) to a high of 1.20 per acre (2.96 birds/ha) (Gallizioli 1965). In Arizona, 17,689,474 acres (7,158,676 ha) are considered core, or prime, Gambel's quail habitat. Applying the density estimates referred to above would yield population estimates for the core range in Arizona of 1.9 million quail during poor years and 20.5 million or more quail during optimal conditions.

Legal Status and Harvest

Gambel's quail are a popular gamebird in all states it inhabits, with the exception of Idaho, where abundance is low and distribution is limited. They make up the vast majority of quail harvest in Arizona (Zornes 2005).

Montezuma Quail

Description

Montezuma quail are sexually dimorphic, the largest and the most strikingly marked of southwestern quail species. Male Montezuma quail have white and black harlequin-marked heads, capped by a russet shock of feathers that forms a nuchal crest. Males possess brown and black checkered backs interlaced with white or light colored feather shafts and have white, spotted black flanks. The breast and underparts are a rich mahogany that turns to black at the rump, which terminates in a stubby, almost nonexistent tail. Females possess a similar head pattern but are cinnamon-colored with brown, black and buff markings. In winter, males average about 6.9 ounces (195 g) and females about 6.2 ounces (176 g). Total length ranges from 8.1 to 9.1 inches (205–230 mm, Stromberg 2000). Both sexes are equipped with long, curved claws with which they excavate the tubers on which they feed. Juveniles can be differentiated from adults by the appearance of the upper primary coverts for each sex and by the appearance of the outer two primaries (P9 and P10).

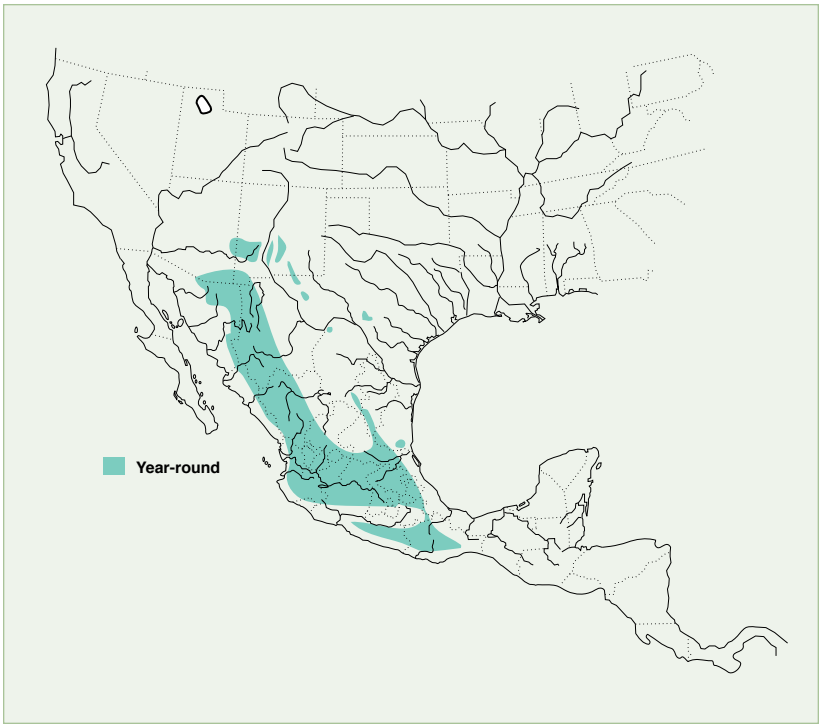
Natural History

Like most gallinaceous birds, Montezuma quail populations are highly dynamic with large annual variation in abundance. Annual precipitation (particularly summer precipitation) has a significant influence on abundance (Brown 1989). Population size in both hunted and unhunted areas is highest

shortly after the young of the year hatch. It declines to its lowest point just before the next hatch. As is typical for quail species, most Montezuma quail probably die in the first year of hatching (Stromberg 1990). No data are available on longevity of wild birds but based on studies conducted on other quail species, few individuals are likely to reach four years of age. Birds in captivity have been reported to reach age seven (Stromberg 2000). Unlike other southwestern quail species, Montezuma quail do not form winter aggregate coveys (Leopold and McCabe 1957).

Reproduction

Montezuma quail pairing typically occurs from late February to March, and nesting usually occurs from mid-June to mid-August (Wallmo 1954, Leopold and McCabe 1957, Bishop 1964). Typically, hens mate with only a single male but may display polyandrous behavior during exceptionally favorable conditions (Stromberg 2000). Nests are made on the ground either on slopes or adjacent to ground structure, such as a tree or a boulder. Most often, nests are covered chambers with a woven canopy of perennial bunchgrass. Little data exist regarding average clutch size for this species. Leopold and McCabe (1957) reported an average clutch size of 11.1 across the species' range and that both males and females incubate eggs. Stromberg (2000) reported that parents share incubation and an average clutch size of 10.6. First broods appear in mid-June to September (Bishop 1964), with the peak hatch occurring in August. Brood size averages 8.4 (Leopold and McCabe 1957). Timing of pairing, nest building and hatching is somewhat variable and dependent on summer rainfall patterns. Covey size varies throughout the year, with pairs of birds most common in late winter. After the hatch, coveys generally are family



groups of 6 to 15 birds. Young birds typically remain with adults for approximately six months after hatching, then disperse and form new coveys. The number of birds per covey declines from posthatch to prehatch due to mortality and dispersion.

Home Range and Movement

Home range for Montezuma quail coveys is relatively small in size. Quality and quantity of habitat components influence home range size. Stromberg (1990) found that radio-marked birds seldom moved more than 200 feet (61.0 m) in a day. Leopold and McCabe (1957) reported that feeding site fidelity occurred in this species and that coveys ranged in an area of fewer than 597 feet (182 m). Coveys typically range over less than 14.9 acres (6 ha) (Brown 1978) although larger movements have been documented. Anecdotally, Montezuma quail that occupy habitats above the Mogollon Rim in Arizona and higher elevations in west central New Mexico likely display short-range, altitudinal

Montezuma Quail in Arizona/AGFD

migrations in response to weather conditions. This phenomenon also was reported by Leopold and McCabe (1957), who suggested the movements were never greater than a few miles.

Mortality and Survival

As with most gallinaceous birds, annual variations in weather have the greatest influence on population levels for Montezuma quail. Montezuma quail are more dependent on summer monsoon precipitation than other southwestern quail. Population carryover from one year to the next appears to have a greater influence on this quail's abundance than for other species, but research regarding this subject is limited. Winter mortality for this species may be high during years that have periods of persistent, heavy snowfall (Leopold and McCabe 1957, Yeager 1966).

Limited data are available regarding important predators of Montezuma quail. Accipiters (Cooper's hawks and northern goshawks) have been documented as predators of this species (Stromberg 1990, 2000). Great-horned owls are abundant within the range of this species and are opportunistic aerial predators. Skunks, raccoons, coatis, opossums, gray foxes, coyotes, and javelina are potential nest predators and may feed on adults and young. Given the popularity of this species as a gamebird, humans are also an important Montezuma quail predator. While hunting pressure has been shown to reduce Montezuma quail abundance in localized areas, it appears to have little impact at the population level (Leopold and McCabe 1957, Bishop 1964, Bristow and Ockenfels 2000). Montezuma quail numbers have been shown to be higher the year following the hunting season in hunted versus unhunted areas (Bristow and Ockenfels 2000).

No data from wild populations, apparently, are available regarding either disease or parasites in this species (Stromberg 2000). Bishop (1964) reported no blood parasites from southeastern Arizona Montezuma quail.

Brood success in Montezuma quail is less variable than for other southwestern quail species, such as scaled quail and Gambel's quail (Brown 1978, Heffelfinger and Olding 2000). Wings from hunter-harvested birds have been consistently collected in Arizona since 1984. Average percentage of juveniles in the Arizona harvest from 1984 to 2005 was 72.7 percent (range 48–83 percent). Given consistent reproductive success, Montezuma quail population size in summer is more dependent on winter survival and population carryover than for other desert quail species (Brown 1989). Maximum

populations are achieved when high summer rainfall follows years of high population carryover (Brown 1979). This may result in greatly larger populations because juvenile survival increases concurrent with increased production the following summer.

Habitat Requirements

Montezuma quail rely heavily on oak-grassland or pine-grassland savannahs except during years of peak abundance and rarely occur in other habitat associations. They do not occur in areas without an adequate grassland component (Brown 1989) and are occasionally associated with other shrub and tree species including catclaw (Brown 1989), mesquite (Bishop 1964) and palo verde (Stromberg 2000). Nearly all studies of Montezuma quail habitat have found areas with high grass diversity and grass cover height associated with a sparse tree overstory of oak (e.g., Arizona white oak or Emory oak) or pine are best for this species. Perennial bunchgrass species most often are used for cover and nesting. These grasses are warm-season species, produced during periods of summer monsoon moisture (July-September). Montezuma quail depend on hiding cover for defense from predators, for nest construction and for thermal protection in all stages of their life cycle (Wallmo 1954, Bishop 1964, R. Brown 1978, 1982, D. B. Brown 1989, Stromberg 2000).

Montezuma quail are approximately 4.0 to 6.0 inches (10–15 cm) tall when standing erect and select for areas with higher horizontal cover than at random locations (Bristow and Ockenfels 2000, 2002, 2004). Montezuma quail rely on their cryptic coloration and on "freezing" as their primary defense from predators (Brown 1989), the effectiveness of which is influenced by grass canopy and grass height. One study

Montezuma Quail habitat in Arizona/AGFD

suggested that aerial predation can be significant (Stromberg 1990), which could account for Montezuma quail selection of taller, relatively dense grass cover (Bristow and Ockenfels 2004).

Spatial arrangement of both grassland and woodland cover is very important for this species due to its survival strategy, small home range, dispersal distances and food habits. Adequate grass horizontal and vertical cover must be well distributed across the landscape to meet the cover needs of this species. The percentage and distribution of suitable habitat patches will determine the amount of use a given pasture receives (Brown 1982), and connectivity between suitable patches is essential for dispersal.

Montezuma quail are vulnerable at night roosts and nests, given both occur on the ground. Nests are constructed with care and are located within tall bunchgrass (Wallmo 1954). Stromberg (1990) described night roost locations as areas with tall grass associated with a guard object, such as a rock. Roost site fidelity has been documented for this species.

Nearly all studies of Montezuma quail habitat have found areas with high grass diversity and grass cover height associated with a sparse tree overstory of oak (e.g., Arizona white oak or Emory oak) or pine are best for this species. Perennial bunchgrass species most often are used for cover and nesting.

Species richness is a measure of habitat quality and rangeland health. Bristow and Ockenfels (2000, 2002, 2004) found Montezuma quail used areas with grass, forb and tree species diversity higher than at random sites.

Nowhere are Montezuma quail commonly found in areas devoid of overstory tree cover. Woodland used most heavily throughout this species range is typically comprised of oak or a combination of oak and pine. Overstory trees provide security, thermal cover and a microclimate conducive to forb production (Bristow and Ockenfels 2000). Rarely are Montezuma quail located more than a few dozen yards from trees (Brown 1989), but they have been documented far from trees (K. Bristow personal communication 2003). Stromberg (1990) reported Montezuma quail most often were found within 20 yards (18.2 m) of oak trees, but there are many examples of this species existing in areas devoid of oaks. Brown (1982) recommended that 20 to 30 percent overstory canopy cover be maintained. Bristow and Ockenfels (2000) reported Montezuma quail selected for overstory canopy of 26 to 75 percent, with optimal levels occurring between 26 and 50 percent.

Food Requirements

Habitat selection by Montezuma quail is dependent not only on available cover but also on the distribution of food plants (Leopold and McCabe 1957, Bishop 1964). Studies of Montezuma quail diet have determined that the bulbs and tubers of yellow nutsedge and Gray' woodsorrel account for the majority of their diet (Bishop and Hungerford 1965, Brown 1982). Both these plants show above-ground growth in summer but may be invisible in fall and spring. Oak woodland provides the microclimates conducive to the production of these and other forbs. Insects and acorns are used in summer, and bulbs and tubers are most often used in fall and winter (Bishop and Hungerford 1965). As with other gallinaceous birds, the diet of six- to eight-week-old Montezuma quail consists primarily of insects.

Moderate livestock grazing, where grass cover requirements are met, is not inconsistent with good Montezuma quail habitat. These quail tend to select the more lightly used patches of a pasture (Bristow and Ockenfels 2000). Brown (1982) found higher densities of quail food items in grazed areas than in ungrazed areas. It seems reasonable that the foods used by quail grow best where grass competition is reduced, suggesting that light livestock grazing directly benefits Montezuma quail. Leopold and McCabe (1957) documented less food availability in areas of very intense livestock grazing. Regardless of livestock impacts on Montezuma quail food abundance, all studies conducted on Montezuma quail habitat stress that diverse, tall grass is a critical component. When grazing over large areas reduces grass cover below that required by Montezuma quail, they cannot use the available food because of the lack of cover (Brown 1982).

Water Requirements

This species does not appear to need or use free water to any great extent (Leopold and McCabe 1957). They reported birds were plentiful in areas that had no sources of free water in Michoacán, Mexico. Likely they use dew, if available but primarily obtain necessary water requirements from food resources (Leopold and McCabe 1957).

Distribution and Abundance

In Arizona, Montezuma quail are restricted to "sky island" habitats in southeastern Arizona and to isolated pockets above and below the Mogollon Rim, north of the Gila River. Montezuma quail have been documented as far west as Prescott in Fort Whipple (Coues 1866) and the Bradshaw mountains (Brown 1989), and they have been reported at elevations up to 10,000 feet (3,048 m) on Mount Baldy, Green's Peak and Escudilla Mountain. Brown (1989) reported this bird to be once common in San Francisco Peaks area north of Flagstaff, Arizona. No recent records from this area exist. Outside Arizona, Montezuma quail are found in western and central New Mexico and as scattered populations in western Texas.

Estimates of density for this species are uncommon, given its limited distribution in the United States and its behavior.

Legal Status and Harvest

Montezuma quail are classified as upland game birds in Arizona, New Mexico and Texas although Texas has no open season for this species.

Mountain Quail

Description

Mountain quail is the largest North American quail. The first written description of mountain quail is attributed to the journals of Lewis and Clark, whose expedition collected specimens along the lower Columbia River. There are no reliable plumage characteristics to distinguish males from females readily across most of their range. Both genders possess straight vertical head plumes and chestnut-colored throat patches. There is subspecific variation in body color, but overall color is dull olive with white barring on the flanks surrounded by chestnut. Body mass of mountain quail during

winter captured in southwestern Oregon averaged between 8.8 ounces and 9.2 ounces (250–260 g) in length. Adults average between 10.6 and 11.4 inches (270–290 mm, Johnsgard 1973). The American Ornithologist's Union (AOU) currently recognizes five subspecies of mountain quail, but the legitimacy of these subspecies has been questioned.

Natural History

Reproduction

Mountain quail are monogamous. Male and female mountain quail can incubate clutches and brood chicks independently (Heekin 1993, Delehanty 1997, Pope 2002). The rangewide prevalence of male incubation and simultaneous clutches is unknown, but it is likely common, at least in Idaho (Beck et al. 2005) and Oregon. Of 148 nests in Oregon from resident and translocated quail, 64 were incubated exclusively by males, 77 were incubated by females and 7 by birds of unknown sex (Pope and Crawford 2001, Scheele, unpublished report 200, Jackle et al. unpublished report 2002, Pope et al. unpublished report 2003, Pope et al. unpublished report 2004; Nelson and Robinson unpublished report 2005). This suggests simultaneous double-clutching likely is common and an important part of the species' reproductive strategy, especially since environmental conditions in the areas these birds inhabit may limit the ability to renest or double brood. Renesting attempts by mountain quail are infrequent (Pope 2002, Beck et al. 2005). The first clutch may be incubated by the male and the second clutch by the female (Delehanty 1995). In Idaho, mean hatching date for nine paired males was June 30; for their mates, peak hatch was July 3 (Beck et al 2005). Monitored known pairs of translocated populations in Oregon also suggest that incubation by the pair often is initiated around the same time (M. Pope and J. Nelson personal communication: 2006). Both members of the pair begin incubation within a few days of each other. This suggests both clutches are nearly complete before incubation begins. In Idaho, males incubated larger clutches and hatched more chicks than did females (Beck et al. 2005).

Mountain Quail nest in Oregon/Richard Vetter

Nests often are highly concealed by an overhead cover of shrubs, inside bunchgrass, under downed logs and even under rocks. Of 26 nests located on Steens Mountain in southeastern Oregon, 9 were concealed by shrubs, 7 by rock, 4 by young juniper, 3 by grass and 3 by downed trees (J. Nelson personal communication: 2006), which is consistent with the nest locations in Idaho (Heekin et al. 1994). In the more mesic

areas of western Oregon, 78 percent of nests were located in edge habitats or in early seral habitats with a shrub component (Pope 2002).

Clutch size. Average clutch size from 34 nests in Idaho and California was 10.9 ± 7.3 (Gutierrez and Delehanty 1999). In Oregon, Pope (2002) reported an average clutch of 11.3 ± 0.3 for 57 nests (40 were resident quail and 17 were translocated quail). In Oregon, 89 nests of translocated quail had an average clutch size of 10.1 ± 0.3 (Oregon Department of Fish and Wildlife unpublished data: 2006).

Nest attentiveness. The incubation period generally is considered to be 24 to 25 days (Johnsgard 1973, Gutierrez and Delehanty 1999). It may be longer in some areas in as much as Pope (2002) reported a mean incubation period of 30 ± 0.6 days (the sample size is 18, range 27–36). Males and females generally take two recesses each day while incubating. Daily time away from nests averaged 164 ± 5.5 minutes (Pope 2002). Paired birds in Idaho spent an average of 59 days for egg laying and incubation, assuming the egg-laying rate was 1.2 days per egg (Beck et al. 2005).

Nest success. Limited studies of nest success for resident birds are available. In an Idaho study, nest success was reported at 77 percent for 13 nests (Heekin et al. 1994). For resident and translocated birds in Oregon, nest success was reported at 70 percent for 57 nests (Pope 2002); for 91 nests from translocated birds in Oregon, nest success was reported at 74 percent. In the southern part of their range, mountain quail may not nest in dry years (Gutierrez and Delehanty 1999). The peak hatching period in Oregon and Idaho is late June and early July (Beck et al. 2005, Pope 2002, Nelson and Robinson unpublished report: 2005). On the western slope of the Sierra in northern California, eight nests hatched between June 16 and July 17 whereas, near Joshua Tree National Monument in southern California, chicks hatched in late May (Miller 1950).

Mountain Quails in Oregon/Richard Vetter

Mortality and Survival

Like most species of quail, mountain quail likely have high mortality and individual lifespans are relatively short. However, few studies have investigated survivorship in mountain quail. Pope and Crawford (2004) found similar survival rates for mountain quail in southwestern and northeastern Oregon, despite differing climate and habitat. During the 150-day monitoring period, mountain quail survival was 0.42 ± 0.04 in the combined areas of Hells Canyon and the Cascade Mountains of Oregon (Pope and Crawford 2004). Male mountain quail were found to have slightly higher survival rates (Pope and Crawford 2004, Nelson and Robinson unpublished report: 2005). This is consistent with the gender ratios determined from the blood samples of 653 mountain quail captured in Oregon between 2002 and 2006, where 52 percent were male and 48

Unlike other North American quail, many mountain quail make seasonal movements between their breeding and wintering ranges. These movements are generally altitudinal in nature, with birds nesting at higher elevations than occupied in winter.

percent were female (Oregon Department of Fish and Wildlife unpublished data: 2006).

Avian predation appears to be the principal cause of mortality with Accipiters most frequently implicated (Gutierrez and Delehanty 1999, Nelson and Robinson unpublished report: 2005). Other raptors, such as great-horned owl, and mammals, such as coyote, bobcat and long-tailed weasel, also are known to prey on mountain quail. In southeastern Oregon, 46 percent of the mortality was attributed to avian predators, 8 percent to bobcat and 46 percent unknown (J. Nelson personal communication: 2006). Mountain quail mortality has been documented during extreme winter weather when snow accumulation is deep or persistent (Gutierrez and Delehanty 1999). In southern California, precipitation may strongly influence survival of young mountain quail. Miller (1950) reported in 1947 that 1 to 2 inches (2.5–5.1 cm) of rain resulted in no or very few young birds; 4 inches (10.2 cm) of rain in 1948 produced ratios of one adult to three young; and 6 inches (15.2 cm) of rain in 1949 produced ratios of one adult to five young.

Home Range and Movement

Unlike other North American quail, many mountain quail make seasonal movements between their breeding and wintering ranges. These movements are generally altitudinal in nature, with birds nesting at higher elevations than occupied in winter. Pope (2002) reported that 53 percent of the mountain quail in the Cascade Mountains of Oregon migrated more than 6.2 miles (10 km) between winter range and breeding range habitats. Home range estimates for the segment of the mountain quail population that did not exhibit migration was 348.4 ± 76.6 acres (141 ± 31 ha) Pope et. unpublished report: 2004). Mountain quail that inhabit lower elevation coastal mountain ranges tend to move less between breeding and wintering ranges. In the southern part of their range in desert habitats, mountain quail disperse following winter rains and the germination of herbaceous plants (Gutierrez and Delehanty 1999).

Habitat Requirements

Mountain quail are adaptable birds and capable of occupying a wide range of plant communities, but are consistently associated with early successional, shrub-dominated communities. In northern California, distance to water, distance to cover, minimum shrub height, maximum shrub height and total shrub cover were the most important components for mountain quail (Brennan et al. 1987). This resulted in mountain quail using areas in proximity to water and to tall dense shrubs in greater proportion than their availability. In California, 71.6 percent of the mountain quail observations in the northern part of the state came from mixed-shrub and mixed-forest communities (Brennan et al. 1987). In central coastal California, mountain quail are found most often in mixed evergreen forest; in southern California, mountain quail are located most often in chaparral and mixed-desert scrub (Gutierrez and Delehanty 1999).

Mountain quail translocated from mesic sites in southwestern Oregon to more xeric areas in Hells Canyon of northeastern Oregon had survival rates similar to resident birds (Pope and Crawford 2004), further suggesting individual adaptability. Resident and translocated mountain quail in Hells Canyon were associated most often with overstories dominated by mixed hardwoods or with conifers that contained a healthy shrub understory, such as an overstory of black cottonwood and a snowberry understory, while quail in the Cascade Mountains selected early successional shrub and sapling stands (Pope et al. unpublished report: 2004).

Mountain quail typically occupy steeper slopes, habitat of greater complexity and more rugged terrain than California quail where the species are sympatric (Gutierrez 1980).

Food Requirements

Mountain quail are opportunistic feeders and primarily consume vegetative matter and are opportunistic. Examples of food items selected across their range include: seeds, berries, nuts, fungus, flowers, bulblets and green vegetation. Invertebrates are the primary animal matter consumed but generally constitute a small proportion of the total dry mass of the diet (Pope et al 2002, Gutierrez and Delehanty 1999). Adult females and chicks during the first weeks of life consume more animal matter than males do. Invertebrates identified in the mountain quail crops include termites, ants, butterflies, earwigs, grasshoppers, beetles and spiders (Pope et al. 2002).

Seeds are consumed from a wide variety of annual and perennial plants. The importance of a particular food item in the diet varies across the range of the species depending on its local abundance. In southwestern Oregon's Cascade Mountains, legume seeds were the most used food item as determined by total dry mass (47 percent) of crop contents (Pope et al. 2002). Mountain quail in California are reported to scratch and dig for underground bulblets to an average depth of 1.6 inches (4 cm) (Gutierrez 1980). Throughout the mountain quail range in California, the most significant shrub species contributing to the bird's diet are ceanothus, manzanita, silk tassel, toyon, poison oak, squaw bush and laurel sumac; important forbs are filarees and legumes; important grasses include bromegrass, fescue, needle-grass and ryegrass (Grenfell et al. 1980). Demonstrating the diversity of vegetative material consumed by mountain quail, 24 plant taxa were identified in the crops of

Mountain Quail habitat in Oregon/Richard Vetter

Mountain quail typically occupy steeper slopes, habitat of greater complexity and more rugged terrain than California quail where the species are sympatric.

Mountain Quail habitat in Washington/Lisa Cross

mountain quail during fall, and 37 plant taxa were identified in the crops of mountain quail collected in winter (Pope et al. 2002).

Distribution and Abundance

Current distribution of mountain quail is restricted to western North America, from southern British Columbia to Baja Mexico, and it includes Washington, Idaho, Oregon, Nevada and California. Mountain quail are typically associated with mountainous terrain from elevations of 765 yards (700 m) to more than 3,281 yards (>3,000 m) (Gutierrez and Delehanty 1999). The natural historic range of mountain quail is not well documented and may have been disguised by translocations that began in the last half of the 19th century. The Columbia River may have been the northern extent of the historic range in Coast and Cascade mountains with translocations responsible for the establishment of populations in western Washington and British Columbia (Crawford 2000).

The distribution and abundance of mountain quail diminished greatly in the Intermountain West during the mid-20th century. In Idaho, the distribution is thought to be 10 percent or less of the historic distribution and was graphically demonstrated in a series of maps from 1938 to 1989 in Brennan (1990). The distribution of mountain quail east of the Cascade Mountains in Oregon also showed significant declines during this same period. However, the abundance and distribution of mountain quail in the eastern part of Oregon has been increasing since the mid-1990s particularly in the John Day River drainage. Mountain quail in California still occupy much of their historic range. In western Oregon, western Washington and much of California, there are extensive areas of suitable brush habitat, whereas suitable habitat in the Intermountain West is linear and often associated with riparian areas, which are thought to be important for wintering mountain quail (Brennan 1990). Degradation of the relatively linear riparian habitats may be responsible for population declines observed in the Intermountain West. The recent improvement in riparian areas may be responsible for population increases in eastern Oregon.

Mountain quail coveys are generally small, consisting of 10 or fewer birds (Gutierrez and Delehanty 1999). Due to the small covey size, the secretive nature of mountain quail, their reluctance to stray far from dense cover and the often remote areas they inhabit, few biologists have been successful at estimating abundance of mountain quail. Brennan (1990) reported population densities in northern California ranged from 31.1 to 90.7 quail per square mile (12 to 35/km2. Pope (2002) acknowledged the difficulty in estimating densities but postulated there were more than 13 quail per square mile (5/km2)

in Hells Canyon and more than 39 quail per square mile (15/km2 in the southern Cascade Mountains of Oregon.

Legal Status and Harvest

Mountain quail are classified as upland game birds in the five western states and one province. Idaho and British Columbia have no open season for mountain quail. Portions of Oregon and Washington are open to mountain quail hunting, while Nevada and California offer seasons. Bag limits and seasons vary within states, depending on known distribution and abundance.

Scaled Quail

Description

Scaled quail have brownish-gray wing, back and tail plumage. The head is topped with a white-tipped crest. Body and neck plumage is bluish with dark tips, creating a scaled appearance. There is very little difference in appearance between sexes, and they are reported as the least dimorphic of all North American quail species (Schemnitz 1994). Sex can be determined by examining the throat plumage, which is white to buff colored in males and is gray with dark streaks in females (Wallmo 1956a, Brown 1989). Males may also display a rich blue coloration in neck and upper breast plumage. One subspecies—C. s. castanogastris from southern Texas and portions of northeastern Mexico—exhibits a russet-orange horseshoe on the abdomen. This abdomen coloration has also been documented in scaled quail in southeastern Arizona (Brown 1989) and occurs in western Oklahoma and southern New Mexico. This quail is slightly larger than the closely related Gambel's quail, with which it occasionally hybridizes (Brown 1989). Total length of adults is reported at 10.0 to 12.0 inches (254–305 mm)

(Schemnitz 1994). Males (6.7 ounces (191 g)) are heavier than females (6.2 ounces (177 g) (Nelson and Martin 1953). Young of the year can be differentiated from adults by light tipped and mottled upper primary coverts in juveniles versus uniform gray colored upper primary coverts in adults. Juveniles retain primaries P9 and P10 through their first year.

Natural History

Scaled quail are associated with mixed desert grasslands and shrublands of northern Mexico and southwestern United States. They roost and nest on the ground. While this species remains common or abundant in portions of its range, populations are generally considered to be declining due to habitat degradation. Scaled quail appear to be sensitive to excessive livestock grazing. They are more apt to run when disturbed, rather than flushing like most other species of quail. Populations are characterized by boom-and-bust cycles, probably in response to weather and environmentally induced

Scaled Quail habitat in New Mexico/Larry Kamees, NMDGF

reproductive failures (Wallmo and Uzzell 1958, Campbell et al. 1973, Schemnitz 1994). However, in contrast to Gambel's quail, scaled quail population response to fall to spring precipitation is less clear across the range of this species. Wallmo and Uzzell (1958) found reproductive success was primarily tied to spring precipitation. Campbell et al. (1973) suggested that summer (April to August) precipitation appeared to be more important in New Mexico. Brown et al. (1978) found that summer precipitation did not have a significant impact on reproductive success for scaled quail in Arizona. Brown (1989) suggested a combination of winter and summer precipitation, plus overwinter survival play a bigger role in Arizona scaled quail abundance. Unlike Gambel's quail in Arizona, neither winter nor summer precipitation are good predictors of fall harvest (M. Rabe personal communication: 2003). Scaled quail harvest in Arizona represents about 10 percent of annual Gambel's quail harvest. Scaled quail do not appear to exist within native range in areas that receive fewer than 6.0 inches (15 cm) of summer precipitation (Brown et al. 1978, Brown 1989). Total male to female ratios are lower than for other quail species, but adult male to female ratios exceed 1:1 (Schemnitz 1994).

Reproduction

Like other quail, sexual maturity is achieved during an individual's first spring (Brown 1989). Pair formation in scaled quail follows winter aggregate covey break-up, typically in March, but as early as February in Arizona (Schemnitz 1994). Calling intensity of males corresponds with peak breeding condition. Peak of calling is quite variable. Brown et al. (1978) reported a range of peak calling dates in Arizona of May 7 through August 4. Wallmo (1956a) and Campbell et al. (1973) reported similar data from both Texas and New Mexico. This species differs from Gambel's quail reproductive strategy in that initial pair bonds may last until conditions are suitable for nesting, as late as August in some cases (Brown 1989). As with Gambel's quail, vitamin A reserves in the scaled quail liver likely positively influence

reproductive success (Brown 1989). Cain et al. (1987) reported no significant influence on reproductive success due to dietary phytoestrogens.

Nests are constructed primarily on the ground of grasses and feathers (Wallmo 1956b, Brown 1989). Occasionally, nests are built above the ground in a low shrub, such as a yucca (K. Bristow personal communication: 2003). Nests occasionally are constructed with overhead cover of woven grass, and usually associated with a guard object, such as a prickly pear, yucca, dead Russian thistle or abandoned farm machinery (Schemnitz 1961, Brown 1989). Eggs are laid in response to favorable conditions. Average clutch size has been reported as 12.7 by Schemnitz (1961) and 14 by Wallmo (1956b). Brown (1989) reports clutches consist commonly of 9 to 16 eggs (range 5 to 22). Incubation lasts 22 to 23 days (Schemnitz 1994). Nest failures are common. Poor nesting success was reported by Schemnitz (1961). Average brood size is relatively high and was reported as 7.8 and 11.5 for Oklahoma (Schemnitz 1961), 8.7 for Colorado (Hoffman 1965), and 8.1 and 8.2 for Arizona (Anderson 1974). Wallmo (1956b) reported polyandrous behavior for this species; although both Campbell et al. (1973) and Brown (1989) reported that no evidence existed that two broods are raised during one year. Brown (1989) suggested males assist in nest construction and will brood eggs if the female is killed. Renesting has been documented in this species following loss of initial nest.

Home Range and Movement

Home range for scaled quail coveys generally is considered larger than that for Gambel's quail and probably is associated with habitat quality. Home ranges for this species during the winter vary from 24.8 to 84.0 acres (10–34 ha) in Oklahoma (Schemnitz 1961), to 175.4 to 519.0 acres (71–210 ha) in western Texas (Wallmo 1956b). Summer ranges are larger, with a reported range of 719.1 to 2,179.5 acres (291–882 ha) (Brown 1989). Movements from summer range to winter range typically are not large (fewer than 2.5 miles (<4 km) (Schemnitz 1994) and are generally into foothill habitats (Brown 1989). Annual movements by individual scaled quail have been documented of up to 59.7 miles (96 km) (Campbell and Harris 1965).

Mortality and Survival

Scaled quail abundance is influenced by annual variation in weather conditions.

Reports documenting predation of scaled quail are rare (Schemnitz 1994). Anecdotal evidence suggests predators that are effective at catching other quail species or that are nest predators. None is reported to have a population level impact on any quail species. Hunting harvest is considered compensatory and appears to have no effect on scaled quail populations (Campbell et al. 1973, Brown et al. 1978).

Reports documenting predation of scaled quail are rare. Anecdotal evidence suggests predators that are effective at catching other quail species or that are nest predators. None is reported to have a population level impact on any quail species.

Scaled Quail habitat in Arizona/AGFD

Few diseases appear to play a large role in population regulation; although, Rollins (2000) theorized that epizootics potentially played a role in population declines in Texas. Unlike Gambel's quail, scaled quail appear to be more resistant to avian malaria (Schemnitz 1994). Like other quail species, scaled quail act as a host to several internal and external parasites. Around 10 percent of scaled quail examined by Medina (2003) in southern Arizona were infected with platyhelminthes and nematodes. Medina (2003) speculated internal parasite loads may inhibit reproduction and may serve as a direct or indirect source of mortality of both adults and young.

Annual brood size is reported to be consistently high for this species, whereas nesting success is low (Schemnitz 1994). However, Brown et al. (1978) reported nesting success in Arizona fluctuated much less than did nesting success in Gambel's quail. Average annual juvenile mortality rates appeared to be very high (86 percent) in New Mexico and total annual mortality for the same populations was reported as high as 83 percent (Campbell et al. 1973). Conversely, Brown et al. (1978) reported that annual nesting success was much more consistent in Arizona scaled quail and that fluctuations in population were more dependent on carryover or overwinter survival.

Habitat Requirements

Scaled quail are primarily linked to desert grasslands although creosote dominated areas of Mexico (Brown 1989) and southwestern New Mexico are occupied. Open, level to rolling habitats are preferred, and rugged slopes and dense stream courses are avoided. Saiwana et al. (1998) asserted a mosaic of mid to late seral grassland communities is needed to maximize scaled quail abundance in southern New Mexico. The species seems to avoid pure grasslands, particularly stands of introduced aggressive grass species, such as Lehmann's lovegrass (Medina 2003), areas that lack high interspersion of shrubs, grasses and forbs (Schemnitz 1994, Medina 2003, Bristow and Ockenfels 2006), and bare ground (Wilson and Crawford 1987, Saiwana et al. 1998). Bristow and Ockenfels (2006) found the species in Arizona to be most abundant in areas with a diverse native grass community of around 50 percent canopy and a canopy of 10 percent shrubs. Treed areas --defined as a tree or shrub more than 1.6 yards (>1.5 m) in height -- were avoided. Stormer (1984) found scaled quail preferred areas with 35 percent shrub cover and 45 percent herbaceous cover as roost sites. Davis et al. (1975), Schemnitz (1994) and Medina (2003) suggested quail numbers were greater in areas of high plant species diversity. Medina (1988) observed quail most often in areas of high forb cover and low perennial grass cover. Schemnitz (1994) indicated this species needed a diverse grass community, with a varied forb component and scattered

shrubs. Interspersed bare ground also appears to be an important habitat component (Wallmo 1956b, Schemnitz 1994, Rollins 2000, K. Bristow personal communication: 2003), probably because this species prefers to run when disturbed (Rollins 2000). In southern Texas, this species selects areas with greater overstory of shrubs and more bare ground than do sympatric bobwhites (Wilson and Crawford 1987).

Food Requirements

Seeds from forbs make up the largest portion of scaled quail diet (Schemnitz 1961, Medina 1988, 2003, Schemnitz 1994). Forbs eaten most often are those species that are considered undesirable as range plants, such as small flowered milkvetch, morning glory, foothill deervetch, lupine (Medina 2003), snakeweed and Russian thistle (Davis et al. 1975, Schemnitz 1994, Schemnitz et al. 1998). Scaled quail feed on a great deal of green herbaceous material, especially during winter and spring (Brown 1989, Schemnitz 1994). This material is likely ingested as a source of Vitamin A prior to reproduction. Seeds of woody plants, such as mesquite, acacias (Davis et al. 1975, Rollins 1981) and spiny hackberry (Medina 2003) are eaten frequently. Fruits and seeds of cacti are readily eaten when available (Brown 1989). Insects are consumed a great deal seasonally by both adults and young (Schemnitz 1994, Medina 2003). Grass seeds, particularly from bristle grasses, also are important food components (Medina 2003). For a more thorough discussion of this subject, see Schemnitz (1994) and Medina (2003).

Water Requirements

As with Gambel's quail, water needs for this species are a source of controversy. Brown (1989) suggested that scaled quail will readily use free water if it is available, but these birds often live far from free water (see Wallmo 1956b), with documented distances as far as 16.0 miles (25.6 km) (Schemnitz 1994). However, early researchers reported low bird abundance and few young in areas devoid of water (Schemnitz 1994). Water needs for this and other quail species likely are dictated by climatic conditions at the time the research is conducted and location.

Distribution and Abundance

This species primarily is found in Chihuahuan Desert grasslands and adjacent habitats and in shrub-invaded grasslands of the southern Great Plains. Native range extends as far south as Hidalgo, Mexico, and as far north as southwestern Kansas and southeastern Colorado (Brown 1989). Scaled quail have been translocated outside native range to central Washington and eastern Nevada (Johnsgard 1973).

Scaled quail abundance estimates are difficult to obtain and vary widely across its range. Density estimates ranged from 0.16 quail per acre (0.4/ha) in portions of south Texas (Figge 1946), to 0.016 per acre (0.038/ha) in Colorado (Hoffman 1965). Generally, they have been considered to be declining throughout the species' range (Brennan 1993, Schemnitz 1994), possibly due to habitat degradation from overgrazing (Schemnitz 1994). Increasing shrub dominance of Chihuahuan desert grasslands, perhaps combined with invasive herbaceous plants, is linked to declines of scaled quail abundance and distribution in Arizona and New Mexico.

Legal Status and Harvest

Scaled quail are classified as an upland game bird throughout much of its range. Hunting seasons currently occur in Texas, New Mexico, Arizona, Colorado, Kansas and Oklahoma.

Masked Bobwhite

Description

The masked bobwhite is 1 of 21 subspecies of the northern bobwhite (Guthery 2000) Although similar to the others in many ways, adaptation to an arid environment that is unique in precipitation and temperature patterns likely has been responsible for the unique aspects of the masked bobwhite's life history.

Male masked bobwhites are characterized by a rusty red breast and a dark head. Some males exhibit a nearly solid black head with only minimal white flecking. Others show a distinct white eye stripe, which may be accompanied by additional white flecks. Females are indistinguishable from females of other bobwhite subspecies; they have light brown underparts with a buff throat and eye stripe. In both sexes, the back is brown with a high degree of dark patterning to each feather.

Adapted to southern climes, the masked bobwhite is characteristically smaller than many quail subspecies, averaging 5.9 ounces (168.6 g) for males and 5.7 ounces (162.8 g) for females (Tomlinson 1975).

Natural History

Reproduction

Courtship and pairing typically begin in early to mid-July with the onset of the monsoon rains. In Arizona, pairs are occasionally observed in spring. Some birds will nest during spring when adequate rainfall exists (Hernandez et al. 2006, Tomlinson 1972a).

Courtship begins with the calling of males--the typical "ah-bob-white" call characteristic of the species. Egg laying begins around August 1, and the peak of hatch is approximately mid-September. The female lays 10 to 20 white eggs. Nests are on the ground in bunchgrass, well-concealed and lined with dead grass (Ough and de Vos 1982, Levy and Levy 1984). Incubation lasts approximately 23 days. Broods consist, on average, of 5 to 15 chicks, with the average being 11 (Tomlinson 1972a).

The breeding season of the masked bobwhite is short with calling lasting only about 70 days and nesting lasting 90 days (Tomlinson 1972a). Since initiation of breeding corresponds to relative humidity in excess of 25 percent (Goodwin and Hungerford 1977), appropriate conditions are short-lived. Heat can impact bobwhite populations further by reducing egg fertility or production (Lehmann 1946, Roseberry and Klimstra 1984), shortening the length of the nesting season (Klimstra and Roseberry 1975, Guthery et al. 1988), and reducing the amount of thermally suitable habitat (Guthery et al. 2001). Guthery et al. (1988) reported that heat reduced the proportion of southern Texas bobwhite males that were producing sperm and the proportion of bobwhite hens that were laying eggs. They also documented shorter breeding seasons for bobwhites in very hot, dry areas, compared with areas that were more temperate and mesic.

In general, productivity of galliformes is reliant somewhat on the ability to renest following nest failure. With greater than 70 percent individual nest failure, those species that ultimately achieve overall success are those with the ability to produce offspring in subsequent nesting attempts. This is difficult or impossible for masked bobwhites.

Bobwhites require between 47 and 55 days to lay and incubate their first clutch (Rosene 1969), and they require between 20 and 34 days between nesting attempts (Burger et al. 1995). A complete nesting cycle—from the first nest to start of the second nest—would require 65 to 89 days. A renesting attempt would be difficult for masked bobwhites to achieve, given their 90-day nesting season. Because of this, the masked bobwhite is at a disadvantage in terms of overall production and may suffer from chronically low productivity (Hernandez et al. 2006).

Mortality and Survival

Annual mortality rates are believed to be similar to the rates for other bobwhite subspecies—about 70 percent (U.S. Fish and Wildlife Service 1995). Most mortality in the Buenos Aires National Wildlife Refuge is attributed to avian predators (Goodwin 1982, U.S. Fish and Wildlife Service 1995). Little is known about predation of masked bobwhites in Mexico, but local ranch personnel attribute many bobwhite deaths to bobcats and house cats, as well as to hawks. At the present time, there is no information on the role of nest predation in the overall mortality rate of the subspecies.

Disease is common in the captive flock, but nothing is known about the presence of disease in the wild populations. It is also unknown how weather affects the wild population. In captive situations, dropping temperatures, especially when combined with wet weather, regularly decimate entire coveys. It is thought, however, that effects would be less for wild birds, whose movements, coupled with habitat choices, likely would minimize deaths due to inclement weather.

Masked Bobwhite in zoo/Mary Hunnicutt

Disease is common in the captive flock, but nothing is known about the presence of disease in the wild populations. It is also unknown how weather affects the wild population. In captive situations, dropping temperatures, especially when combined with wet weather, regularly decimate entire coveys. It is thought, however, that effects would be less for wild birds, whose movements, coupled with habitat choices, likely would minimize deaths due to inclement weather.

Masked Bobwhite male in Arizona/Mary Hunnicutt

Home Range and Movement

The only research regarding masked bobwhite home-range size and movements was done by Simms (1989). Home ranges for reintroduced bobwhites in Arizona averaged 24.7 acres, (10.0 ha) during the breeding season (mid-May to mid-October) and 28.2 acres, (11.4 ha) during the nonbreeding season. Overall home range size was 26.9 acres, (10.9 ha). Distances between release locations and sites of first trapping averaged 1.9 miles (3.1 km) but ranged from 70.0 yards (64m) to 14.7 miles (23.7 km). Seventy-two percent of birds moved fewer than 0.6 mile (1 km) from release site to home-range center, 33 percent moved between 0.9 and 2.5 miles (1.5–4.0 km) and 6 percent moved more than 6.2 miles (10 km).

Habitat Requirements

Early accounts of masked bobwhite habitat described landscapes consisting of level, diverse grasslands of moderate elevation interspersed with woody cover and characterized by an abundance of seed-producing plants (Hernandez et al. 2006). Bobwhites have been described as inhabiting grassy plains, river valleys and foothills in the lower Sonoran zone but not brushy canyons (Grinnell 1884, Van Rosem 1945, Brown and Ellis 1977). Tomlinson (1972a, 1984) concluded that the best habitat consisted of open desert grasslands located within a 831-yard (760 m) elevational band intersected by brushy areas.

Food Requirements

Much remains unknown about food habits of the masked bobwhite. Primary foods are seeds, insects and green forbs (Bendire 1892, Cottam and Knappen 1939). Stomach contents of 10 Sonoran bobwhites revealed seeds from a variety of plants, including whiteball acacia, ground cherry, panic grasses, dayflower and partridge pea, as well as grasshoppers (Cottam and Knappen 1939).

Water Requirements

Whether masked bobwhites, or northern bobwhites in general, need free water is a matter of controversy. According to Guthery (2000), bobwhites obtain water from three sources: metabolic water produced from food, preformed water obtained from moist food (e.g., invertebrates, berries, greens) and free water (e.g., ponds and dew). Guthery (2000) stated that metabolic water alone is insufficient for bobwhites inhabiting semiarid environments but can provide 25 percent of their needs. Preformed water is prevalent in leafy greens; as much as 90 percent of their weight can be water. Insects as well may contain up to 60 percent water. Metabolic and preformed water combine to provide Bobwhites with an adequate supply to survive and thrive. However, in more arid environments such as in Arizona or Sonora in May and June prior to monsoon, there

may be few insects or moisture-laden foods. At these times, the birds may need to turn to free water for their needs. Whether they need free water or not, masked bobwhite are known to utilize it when it is available.

Distribution and Abundance

Historic distribution of the masked bobwhite was 29.8 to 49.7 miles (48–80 km) north of the international boundary in Altar and Santa Cruz valleys of Arizona south to southern Sonora (Brown and Ellis 1977). Now the range is confined to the Buenos Aires National Wildlife Refuge, its surrounding area in southern Arizona and at least three private ranches in central Sonora, Mexico.

Mexico

Historic habitat in Mexico ranges from the U.S. border to southern Sonora (U.S. Fish and Wildlife Service 1995). Currently, the range is on at least two private ranches in a small area southwest of Benjamin Hill, Sonora. Despite extensive searches from 1967 through 1972 (Tomlinson 1972b), surveys done in the 1990s (Dobrott 1992) and 2000s, no other populations of the subspecies have been located. Range reduction is attributed to drought and heavy grazing. In addition, large-scale conversion of native grasslands to buffelgrass contributed to the loss of masked bobwhite habitat by greatly decreasing plant diversity (Hernandez et al. 2006).

Historic population numbers are unknown. Thirty-five years of calling male surveys conducted on Rancho El Carrizo indicate that population levels varied substantially, apparently in response to rainfall (Camou-Luders et al. 1998). Annual detections of calling males varied from a low of 0 to a high of 60.

Current populations are very small, with only between three and six calling males being detected on call-count surveys in 2006 and 2007. The bird appears to be near extinction in the heart of its range.

Arizona

Originally described as locally plentiful in the Altar Valley of Arizona in the mid 1800s, bobwhites declined drastically and were considered extirpated by the turn of the 20th century (Brown 1904). Excessive grazing pressure coupled with prolonged drought was blamed (Brown 1900, 1904).

Currently, the population on and around Buenos Aires National Wildlife Refuge is believed to be near zero but occasional detections are reported a few times a year.

Translocations and Releases

Since 1937, masked bobwhites have been translocated into areas of Arizona and New Mexico. That year, 157 were captured and released in the United States (Lawson 1951, Ligon 1952). At that time, the habitat of the Altar Valley, Arizona, was in such poor condition that releases had to be done outside the historical range of the bird (Arrington 1942). These translocation efforts failed. Numerous additional translocations took place over the following 50 years, with no success. In 1999, 37 birds were captured in Sonora. Twenty-five of them survived to be translocated to the Buenos Aires National Wildlife Refuge. Descendants of those birds persisted through 2004 and were thought to be self-sustaining until prolonged droughts in 2005 and 2006 evidently contributed to their demise.

A captive flock was established at Patuxent Wildlife Research Center in Maryland in the late 1960s. Captive-reared birds were

Currently, in Arizona, the wild masked bobwhite population is hovering near zero. Releases of captive stock were suspended in 2004 as a result of recommendations stemming from a wildlife and habitat management review. At that time, a small population persisted at two locations on the refuge.

bred there for release in the Altar Valley of Arizona until 1996 when responsibility shifted to the staff of Buenos Aires National Wildlife Refuge. In all, more than 30,000 captive-reared masked bobwhites have been released into the wild since 1937, including more than 21,000 on the Buenos Aires National Wildlife Refuge. The population is not self-sustaining; although captive-reared individuals interbred with the aforementioned stock from the 1999 translocation, and their descendants persisted in very small numbers for five years (Garcia-Solorzano et al. 2006).

Currently, in Arizona, the wild masked bobwhite population is hovering near zero. Releases of captive stock were suspended in 2004 as a result of recommendations stemming from a wildlife and habitat management review. At that time, a small population persisted at two locations on the refuge. It was thought they may be self-sustaining. Following two years of virtually no winter rain (winters 2005–2006 and 2006–2007) the small group of birds dwindled. At the time of writing, there appear to be very few wild birds existing on Buenos Aires National Wildlife Refuge.

Legal Status and Harvest

The masked bobwhite quail has been on the federal endangered species list since the passage of the Endangered Species Conservation Act of 1960 (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.

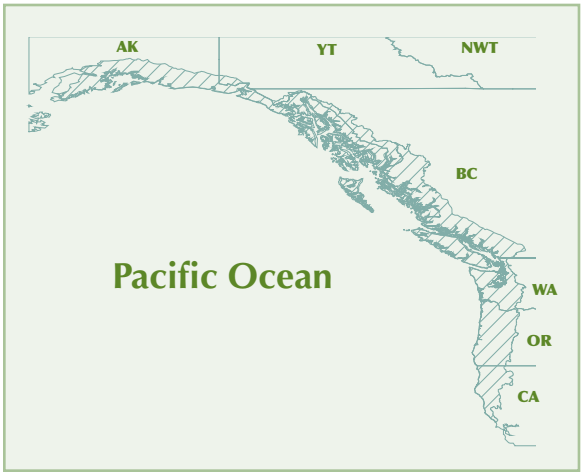
The masked bobwhite also is listed by the government of Mexico as "Especies de Fauna en Peligro de Extinction en Mexico" (Subsecretaria Forestral y de la Fauna 1982). As designated by the Convention on International Trade in Endangered Species, the masked bobwhite is a species in danger of extinction and is on the International Union for Conservation of Nature and Natural Resources' 1986 "Red List of Threatened Animals" (listed and endangered). Because of the masked bobwhite's valid status as an endangered species, harvest of this formerly popular game bird subspecies is illegal.

Status of Western Quail

in Specific Bird Conservation Regions

Bird Conservation Region 5: Northern Pacific Rain Forest

(Includes portions of Washington, Oregon, and California)



The coastal rainforest stretches from the western Gulf of Alaska south through British Columbia and the Pacific Northwest to northern California. Its maritime climate is characterized by heavy precipitation and mild temperatures. Hills and mountains in the region are dominated by forests of western hemlock and Sitka spruce in the far north, with balsam fir, Douglas -fir and coast redwood becoming more important farther south. Broadleaf forests are found along large mainland river drainages. Interior valleys contain most of the human population and are important areas for a wide variety of agricultural activities (e.g. ,Washington's Skagit Valley, Oregon's Willamette Valley). The coast of the Northern Pacific Rainforest is characterized by river deltas and pockets of estuarine and freshwater wetlands set within steep, rocky shorelines.

California Quail

Current Trend

In most areas, California quail populations have experienced long-term declines in BCR 5. Quail are still locally abundant where suitable habitat is present.

Population Estimate And Population Density

No reliable estimate of population size for BCR 5 is available. Interior valley populations in areas of suitable habitat have been documented to be 259 quail per square mile. California quail are not considered native to the portion of BCR 5 from Douglas County, OR north. Most populations are found in association with disturbed habitats, or areas converted to agriculture.

Desired Population Level

Since population estimates are not available, harvest by hunters are used as an index to quail abundance. In California, the "game take hunter survey" estimates the number of hunters and take of each species by county. Because this BCR includes only portions of a number of counties, it is difficult to estimate the harvest by hunters. In Oregon, annual harvest is estimated at 2,200. Harvest of California quail in western Washington is low. The desired population goal is to maintain or enhance California quail at the current harvest level in BCR 5.

In most areas, California quail populations have experienced long-term declines in BCR 5. Quail are still locally abundant where suitable habitat is present.

Management Issues

The single largest issue in BCR 5 for California quail is large (landscape) changes in landuse, primarily shifts in agricultural production (e.g. cereal grains to commercial grass seed production) and increased utilization. Limiting factors of less importance include the lack of periodic disturbance in lower elevation forests and brushlands to create early successional habitats preferred by California quail. In areas where disturbance does occur, such as caused by timber harvesting, herbicide treatment of all deciduous woody vegetation is a common practice that lowers the habitat values of resulting seral habitats. Domestic and feral cat populations also are believed to have a negative effect on quail populations in areas near human habitation.

Habitat Objectives

Likely due to their nonnative status and that a large portion of this temperate rainforest BCR5 does not provide suitable habitat for California quail, existing Partner in Flight (PIF) plans, State Wildlife Action Plans, and Joint Venture Management Plans do not specifically address the habitat needs of California quail. Specific habitat objectives are not identified, but see management recommendations below.

Likely due to their nonnative status and that a large portion of this temperate rainforest BCR5 does not provide suitable habitat for California quail, existing Partner in Flight (PIF) plans, State Wildlife Action Plans, and Joint Venture Management Plans do not specifically address the habitat needs of California quail.

Management Recommendations

- Retain and encourage native deciduous shrubs/trees in areas of low elevation disturbance, such as created by timber harvest.

- Use periodic disturbance of low elevation habitats to maintain a portion of early successional habitats. Disturbance can be mechanical (e.g., mowing, disking) or by fire.

- Encourage plant diversity of early successional habitat. Plant diversity beneficial to California quail can be increased by seeding with legumes.

- Maintain availability of escape and roosting cover. Simply retaining "old fence rows" can benefit California quail.

Mountain Quail

Current Trend

Historical evidence suggests that mountain quail may not be native to BCR 5 north of the Columbia River. In general, populations of mountain quail in BCR 5 are stable and the density increases from north to south.

Population Estimate

Mountain quail are secretive and difficult to detect. No reliable method has been developed to estimate population size. Population densities in suitable habitat have been reported at more than 38.9 quail per square mile on the west slope of the southern Cascade Mountain in Oregon and 31.1 to 90.7 quail per square mile in northern California.

Desired Population Level

Since population estimates are not available, hunter harvest by hunters is used as an index

to quail abundance. Total annual harvest of mountain quail in BCR 5 is around 86,000 birds. In California the "game take hunter survey" estimates the number of hunters and take of each species by county. Because this BCR includes only portions of a number of counties, it is difficult to estimate the harvest by hunters. A rough estimate for annual harvest in California in this BCR 5 is 50,000. In Oregon, average annual harvest is estimated at 36,000. Harvest of mountain quail in western Washington is less than 1000 birds. Sport harvest will be used as an index to mountain quail abundance. The desired population goal is to maintain or enhance the current total mountain quail harvest level in BCR 5 and serve as a source population for translocations to other suitable BCRs.

Management Issues Limiting Factors

Limiting factors include the lack of periodic disturbance in forested habitats and late seral brushland habitat (e.g., Chaparral and Ceonothus shrubland)

Habitat Objectives

Maintain shrubland and earl successional forest habitats with small openings. Historically these habitats likely were created by periodic fire. Existing management plans (e.g., Oregon Conservation Strategy 2006, Northwest Forest Plan 2004and Conservation Strategy for Landbirds Coniferous Forests of Western Oregon and Washington 1999) emphasize late-successional forests, wetlands and species of conservation concern and do not specifically address the habitat needs of mountain quail.

Management Recommendations

- Retain and encourage deciduous shrubs/ tress in areas of disturbance, such as produced by timber harvesting. The increased use of herbicides to reduce shrubs following timber harvest may eliminate potential nesting areas. Following Early Seral Forest recommendation and conservation actions in (Section F) in Conservation Strategy for Landbirds in Coniferous Forests of Western Oregon and Washington, 1999 will likely have ancillary benefits for mountain quail.

Samson Butte - Mountain Quail habitat in Oregon/Micael Pope

- Protect existing shrub communities. These communities often are removed to reduce fire hazard or are converted to timber production. These shrublands are identified as one of the specialized and local habitats in the 2005 Oregon Conservation Strategy2006.

- Use periodic disturbance of shrubland habitats (e.g., Chaparral and Ceonothus brushlands) to maintain an early seral component of up to 50percent of stand. Disturbance should be conducted in a mosaic to increase amount of edge between later and early successional shrub communities. Disturbance can be mechanical or by fire.

- Manage and maintain corridor habitats between breeding and winter ranges. Many mountain quail exhibit migratory

behavior between high elevation breeding ranges and spatially distinct lower elevation winter range. Suitable mountain quail habitat (shrub/early successional forest) must be maintained between summer and winter ranges.

- Maintain or restore more than 30percent of the historical extent of riparian habitat in each major watershed, per the Oregon Conservation Strategy2006).

Bird Conservation Region 9: Great Basin

(Includes portions of California, Idaho, Nevada, Oregon, Utah and Washington)

This large and complex BCR includes the Northern Basin and Range, the Columbia Plateau, and the eastern slope of the Cascade Mountains. This area is dry due to its position in the rain shadow of the Cascade Range and the Sierra Nevada. Grasslands, sagebrush and other xeric shrubs dominate the flats and lowlands, with pinion-juniper woodlands and open ponderosa pine forests on higher slopes. Lodgepole pine/sub-alpine fir forests occur at higher elevations on north-facing slopes.

California Quail

Current Trend

California quail's long-term population trends fluctuate across BCR 9 with no discernable trend. Quail are locally abundant where suitable habitat is present.

Population Estimate and Population Density

There is no published estimate of California quail population size for BCR 9. Most populations are found in association with brushy riparian corridors, disturbed habitats or agriculture lands.

Desired Population Level

Hunter harvest is used as an index to California quail abundance. Total harvest in BCR 9 is currently 457,600. Of this total, an annual average of 148,000 are harvested in Idaho, 152,800 in Washington, 52,000 in California, 59,000 in Oregon, 300 in Utah and 45,000 in Nevada. The desired population goal is to maintain or enhance the current total California quail harvest level in BCR 9.

Management Issues Limiting Factors

Landscape changes—primarily clean farming methods, degraded riparian conditions due to burning and grazing practices, road construction (improved roads or dirt and gravel roads), water extraction, inappropriate recreational use levels, invasive plants and urbanization—are primary issues limiting California quail populations. Water distribution also may be a limiting factor. Domestic and feral cat populations negatively affect quail populations in areas near human habitation.

Habitat Objectives

Existing Partners in Flight (PIF) plans, Joint Venture Management Plans and State Wildlife Action Plans do not specifically

address the habitat needs of California quail. However, the implementation of these plans will benefit California quail. State gamebird management plans discuss California quail habitat needs in varying degrees. Habitat objectives for BCR 9 include:

- Assess existing habitat conditions.

- Convert existing annual grass habitat to perennial bunchgrass habitat.

- Enhance existing degraded riparian areas, seeps and springs.

- Determine and maintain a required residual herbaceous cover height for nesting and brood rearing.

- Identify and maintain minimum distance between water sources in appropriate areas.

Management Recommendations

- Identify potential and existing habitats using imagery.

- Plan habitat enhancements and improvements at watershed scale.

- Assist land-management agencies and private landowners in identifying and implementing upland and riparian habitat enhancements.

- Increase plant diversity in early successional habitats. (e.g., a diversity of plants is beneficial to California quail and can be increased by seeding with native legumes).

- Maintain or increase availability of dense escape and roosting cover. Simply retaining old fence rows can benefit California quail. Artificial escape or roosting structures and brush piles are readily used by California quail.

- Develop riparian wildlife objectives and quail habitat best management practices and incorporate them into Farm Bill conservation programs.

- In cooperation with USDA, Natural Resources Conservation Service (NRCS), develop metrics that provide quantified wildlife outputs for NRCS project proposals.

- Restore fully functioning riparian terrestrial wildlife habitat through progressive livestock grazing- strategy design, riparian fencing and restoration of hydrologic function on a continuously increasing percentage of existing degraded riparian areas, seeps and springs. Monitor to establish a more specific target acreage.

- Restore riparian plant communities invaded by nonnative and other non-desirable plants.

- Maintain vigorous, self-sustaining understory of grasses and forbs, with particular emphasis on seed-set and dispersal to sustain seed- eating wildlife on a continuously increasing percentage of quail range. Monitor to establish a more specific target acreage.

- Strive to maintain range site health by keeping soil erosion within natural limits.

- Identify and encourage acquisition—by trade, fee-title purchase or conservation easement—of private lands that are particularly valuable to quail and in danger of conversion to uses that would decrease viability as quail habitat.

- Contact and encourage local planning authorities to protect quail habitat through appropriate zoning.

- Seek partnerships with landowners, land-management agencies and conservation organizations to protect, maintain and improve habitat for California quail.

- Work with land-management agencies, individuals and conservation organizations to provide water sources for quail and other wildlife. Optimal quail range should have water sources spaced no more than 1 mile (1.6 km) apart.

- Where California quail escape cover is lacking, work with land-management agencies and private landowners to provide such escape cover, particularly near water sources.

- Manage stands of brush species for diversity of structure, seral stage and optimal edge effect. This may include creation of fire breaks within chaparral stands. Management can be through the use of equipment or fire.

- Manage grazing at appropriate levels on a continually increasing percentage of quail range to maintain suitable escape cover and areas of habitat dominated by forbs, rather than annual grasses.

- Protect riparian areas from inappropriate grazing by livestock, fire and excessive water extraction.

Mountain Quail

Current Trend

Mountain quail populations east of the Cascade and Sierra Mountains have declined dramatically (Gutierrez and Delehanty 1999). Populations in eastern Washington, eastern Oregon, southwestern Idaho and central Nevada are in jeopardy of extirpation (Vogel and Reese unpublished data: 2002). Generally, mountain quail populations have declined in BCR 9.

Population Estimate and Population Density

Mountain quail are secretive and difficult to detect. No reliable method has been developed to estimate population size. Population densities in suitable habitat have been reported at more than 38.9 per square mile (15 /km2) on the western slope of the southern Cascade Mountains in Oregon and 31.1 to 90.7 per square mile (12 -35 /km2) in northern California.

Desired Population Level

Hunter harvest is used as an index to mountain quail abundance. Total annual harvest in BCR 9 currently is 12,560, including an average of 3,500 harvested in Oregon, 8,000 in California and 1,060 in Nevada. Mountain quail are not hunted in Idaho or Washington within BCR 9. The desired population goal would maintain or enhance the current total mountain quail harvest level in BCR 9.

Mountain Quail nest in Oregon/Michael Pope

Management Issues Limiting Factors

Primary limiting factors of mountain quail habitat in BCR 9 include poor mountain shrub community health, degraded riparian condition from livestock grazing, burning, water extraction, inappropriate recreational-use levels and invasive plants, climate change, urbanization, and water distribution.

Habitat Objectives

Existing PIF plans, Joint Venture Management Plans and State Wildlife Action Plans specifically address the habitat needs of mountain quail. Habitat objectives for mountain quail include:

- Manage for a patchwork mosaic of interconnected mountain brush communities of native plants and appropriate successional stages on a landscape scale.

- Restore natural disturbance regimes, particularly fire.

- Reconnect fragmented, vertical stringers to provide for contiguous elevational movements i.e., seasonal migration) of resident bird species.

- Promote growth of fruit- bearing shrubs, such as hawthorn, chokecherry and serviceberry.

Management Recommendations

So, managing and maintaining corridor habitats between breeding and winter ranges of mountain quail are priority recommendations. Many mountain quail exhibit migratory behavior between high elevation breeding ranges and spatially distinct lower elevation winter range. Suitable mountain quail habitat (shrub or early-seral forest) must be maintained between summer and winter ranges.

Mountain quail populations east of the Cascade and Sierra Mountains have declined dramatically. Populations in eastern Washington, eastern Oregon, southwestern Idaho and central Nevada are in jeopardy of extirpation.

Others include:

- Maintain or restore riparian habitat in each major watershed.

- Develop and support consistent survey techniques within BCR 9 to monitor populations and distribution.

- Encourage interstate cooperation to expand population and distribution of mountain quail to suitable habitat using trap and translocation techniques.

- Support control of invasive plants (e.g., noxious weeds, annual grasses) that have degraded habitat and that have increased fire frequency. Decrease invasive plants on mountain quail range.

- Identify and encourage acquisition—by trade, fee-title purchase or conservation easement—of private lands that are of value to mountain quail and in danger of being developed. Summer and winter ranges, as well as corridors between them, should be considered.

- Contact and encourage all local planning authorities to protect quail habitat through appropriate zoning.

- Seek partnerships with landowners, land-management agencies and conservation organizations to protect, maintain and improve habitat for mountain quail.

- Work with land-management agencies, individuals and conservation organizations to provide water sources for quail and other wildlife in dry areas. Optimal quail range should have water sources spaced no more than 1.0 mile (1.6 km) apart.

- Manage stands of brush species for diversity of structure, seral stage and optimal edge effect. This may include creation of fire breaks within chaparral stands. Management can be through the use of equipment or by fire.

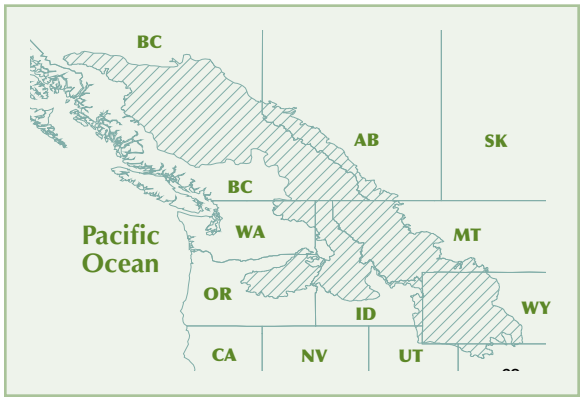
- Manage grazing at appropriate levels to maintain suitable escape cover. Manage some areas of habitat dominated by forbs as a continually increasing percentage of quail range.

- Protect riparian areas from inappropriate grazing by livestock, fire and excessive water extraction.

Hunter harvest is used as an index to California quail abundance. Within this BCR, California quail are not hunted in Montana and Wyoming and very limited harvest occurs in Idaho and Washington. Average annual harvest of California quail in Oregon within BCR 10 is estimated at 17,300.

Bird Conservation Region 10: Northern Rockies

(Includes portions of Idaho, Montana, Washington, Oregon, and Wyoming)



Included in this area are the Northern Rocky Mountains and outlying ranges in both the United States and Canada, and also the Intermontane Wyoming Basin and Fraser Basin. The Rockies are dominated by a variety of coniferous forest habitats. Drier areas are dominated by ponderosa pine, with Douglas- fir and lodgepole at higher elevations and Engelmann spruce and subalpine fir even higher. More mesic forests to the north and west are dominated by western larch, grand fir, western red cedar and western hemlock. The Wyoming Basin and other lower-lying valleys are characterized by sagebrush shrubland and shrub steppe habitat, much of which has been degraded by conversion to other uses or invasion of nonnative plants.

California Quail

Current Trend

Californians have distribution in BCR 10, but their population there is stable to increasing. Successive years of "mild" winter conditions foster population increases.

Population Estimate and Population Density

No reliable estimate of California quail population size for BCR 10 is available. Most of BCR 10 is not considered suitable habitat for California quail, but quail are locally abundant in areas of suitable habitat, which typically occurs near human development, agricultural activities and low -elevation riparian areas. California quail are not considered native to BCR 10 and current distribution represents the northern (Washington) and eastern (Idaho) limits of the species. During winter, birds may gather in coveys numbering in the hundreds to a thousand or more in this BCR.

Desired Population Level

Hunter harvest is used as an index to California quail abundance. Within this BCR, California quail are not hunted in Montana and Wyoming and very limited harvest occurs in Idaho and Washington. Average annual harvest of California quail in Oregon within BCR 10 is estimated at 17,300. The desired population goal would maintain or enhance the current California quail harvest level in BCR 10.

Management Issues Limiting Factors

High- elevation coniferous forests are not the preferred habitat of this species, but represents the majority of habitat in BCR 10. Cold weather and deep snow prevent ground foraging and limit the distribution of California quail to lower elevations in BCR 10. California quail in BCR 10 often are associated with human development and agricultural activities.

Habitat Objectives

Because of the nonnative status of California quail and the large portion of BCR 10 unsuitable habitat for the species, existing Partner in Flight (PIF) plans (e.g., Conservation Strategy for Landbirds in the Northern Rocky Mountains of Eastern Oregon and Washington 2000), State Wildlife Action Plans, and Joint Venture Management Plans (e.g., Coordinated Implementation Plan for Bird Conservation in Eastern Oregon 2005) do not specifically address the habitat needs of California quail. However, implementation of these plans will provide ancillary benefits to California quail. Specific habitat objectives were not identified, but see the management recommendation below.

Management Recommendation

- Maintain and enhance riparian woodlands and riparian shrub habitat at low elevations, particularly those in association with human and agricultural developments. Riparian woodlands and shrubs are priority habitat s identified by the Intermountain Joint Venture, and will provide benefits to wide variety of species, including California quail. Consistent with the PIF plans, at least 30percent of this historical extent of riparian habitats within each watershed be restored or enhanced by 2025.

Mountain Quail

Current Trend

Populations have suffered long-term declines in BCR 10 and currently occupy a small proportion of the species' historical distribution. Population appears to be increasing and distribution expanding in the John Day River watershed of Oregon. Translocation efforts are ongoing in Washington and Idaho, to augment and or restore mountain quail populations to historical habitats.

Mountain Quail habitat in Washington /Lisa Cross

Mountain Quail habitat in Oregon/Michael Pope

Population Estimate Population Density

Mountain quail are secretive and difficult to detect. No reliable method has been developed to estimate population size. Population densities in suitable habitat have been reported as greater than 13.0 per square mile (5/km2) on the Oregon side of Hells Canyon.

Desired Population Level

Expand current distribution to suitable and restored habitat within the historic range of mountain quail, and Maintain population densities of at least 13.0 per square mile (5/km2) in areas of suitable habitat.

Management Issues Limiting Factors

Mixed forests containing both coniferous and deciduous trees and shrubs are the favored habitat of mountain quail. The primary limiting factor appears to be the degradation of riparian areas, which fragments suitable habitat. Invasive plants, particularly noxious weeds and annual grasses, have altered native habitat and increased fire frequency. The availability of seeps, springs and free water may limit distribution of mountain quail at more xeric sites in BCR 10. Limited mountain shrub component and late seral stage of coniferous forests also may be restricting mountain quail populations.

Habitat Objectives

In cooperation with interested landowners and land management agencies, riparian tree and shrub habitat should be increased to improve habitat and increase connectivity between suitable habitats. Noxious weeds that degrade riparian and shrub habitats should be eradicated, and spread of annual grasses, which limits forb availability and increases fire frequency, should be controlled.

Management Recommendation

- Maintain and enhance riparian woodlands and riparian shrub habitat at low elevations, particularly those in association with human and agricultural developments. Riparian woodlands and shrubs are priority habitats, identified by the Intermountain Joint Venture and will provide benefits to a wide variety of species. Consistent with the Conservation Strategy for Landbirds in the Northern Rocky Mountains of Eastern Oregon and Washington (2000), it is recommended that at least 30percent of the historical extent of riparian habitats within each watershed be restored or enhanced by 2025.

- Manage and maintain corridor habitats between breeding and winter ranges of mountain quail. Many mountain quail exhibit migratory behavior between high- elevation breeding ranges and spatially distinct lower-elevation winter range. Suitable mountain quail habitat (shrub/early successional forest, riparian corridor) must be maintained between summer and winter ranges.

- Develop and support consistent survey techniques within BCR 10 to monitor mountain quail populations and distribution.

- Encourage interstate cooperation to expand populations and distribution of mountain quail to suitable habitat by means of trap and translocation techniques.

- Support control of invasive, noxious weeds and, annual grasses that have degraded habitat and increased fire frequency.

Bird Conservation Region 15: Sierra Nevada

(Includes portions of California and Nevada)

The Sierra Nevada range rises sharply from the Great Basin on the east and slopes gently toward the Central Valley of western California. Vegetation at lower elevations is dominated by ponderosa pine in the west, lodgepole pine in the east, and fir, spruce and alpine tundra at higher elevations. Nearly the entire BCR is within California.

Mountain Quail

Current Trend

Mountain quail occur in much of the Sierra Nevada BCR, except at some of the higher elevations. Breeding bird surveys within California for mountain quail show a trend that essentially was stable from 1968 through 2003. Statewide, the trend in hunter bag from California's game-take hunter survey declined from approximately 200,000 in 1992 (earliest year that quail species were segregated in the survey) to approximately 135,000 in 2004. Some of this decrease may be due to a 15- percent drop of upland game hunters in California during this period (as indicated by upland game bird stamp sales).

Population Estimate Population Density

No reliable estimate of population size is available for mountain quail in BCR 15. Brennan and Block (1986) reported a density of 0.112 per acre (0.276/ha) at a study site in the northern Sierra Nevada.

Desired Population Level

Since reliable population estimates are not available, hunter harvest is used as an index to quail abundance. The game-take hunter survey estimates the number of hunters and take of each species by county. The estimated average annual harvest of mountain quail during the years 2002, 2003 and 2004 in counties that extend into this BCR is 54,000. The desired population

goal is to maintain or enhance the existing population, as measured by the estimated hunter harvest by level.

Management Issues Limiting Factors

Management issues and limiting factors relative to mountain quail in the Sierra Nevada BCR include the lack of disturbance through fire and logging that is needed to maintain early successional shrubs and forbs and the loss or fragmentation of habitat through construction of residences and roads. In some cases, grazing may be negatively impacting habitat for mountain quail, particularly in meadows and riparian areas. Aspen communities are an important component of mountain quail habitat but in some locales are degraded from invasion by white fir.

Habitat Objectives

The "Sierra Nevada Bird Conservation Plan" (Siegel and DeSante 1999) lists a number of habitat objectives, some of which could be expected to benefit mountain quail. These include protecting existing, high-quality meadow, riparian and oak-woodland habitat. In addition, maintenance of early successional shrub stands and forbs also could benefit mountain quail. Additional habitat objectives have not yet been delineated.

Management Recommendations

- Identify and encourage acquisition—by trade, fee-title purchase or conservation easement—of in-holdings within public lands that are of value to mountain quail and in danger of development. Summer and winter ranges, as well as corridors used between them, should be considered.

- Encourage local planning agencies to protect habitat through appropriate zoning.

- Encourage and maintain deciduous shrubs and trees in areas of disturbance, such as those produced by timber harvest. Discourage the use of herbicides following timber harvest.

- Protect existing shrub communities from removal to reduce fire danger or increase timber production.

- Use periodic disturbance of shrubland habitat to maintain early successional components. Disturbance should be conducted to create a mosaic to increase the amount of edge between later and early seral shrub communities. Disturbance can be mechanical or by fire.

- Manage and maintain corridor habitats between summer and winter ranges of mountain quail. Many mountain quail migrate between high elevation summer ranges and disjoint winter ranges. Suitable habitat (shrub and seral forest) should be maintained in summer and winter ranges.

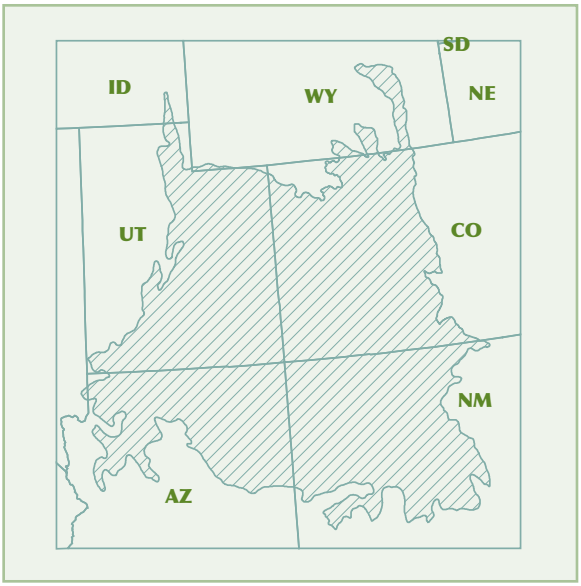
- Provide mountain quail for transplant to other states to re-establish populations where they have been extirpated.

- Seek partnerships with landowners (especially timber companies), land-management agencies and conservation organizations to protect, maintain and improve habitat for mountain quail.

Gambel's Quail habitat in Arizona/AGFD

Bird Conservation Region 16: Southern Rockies and Colorado Plateau

(Includes portions of Arizona, Utah, Colorado, and New Mexico)



This topographically complex region includes the Wasatch and Uinta mountains to the west and the southern Rocky Mountains to the east, separated by the rugged tablelands of the Colorado Plateau. The southern end of this BCR is marked by the Mogollon Plateau in Arizona. Various coniferous forest types (often lodgepole or ponderosa pine) are interspersed with aspen in higher elevations. These are replaced by pinion-juniper woodlands in the lower plateaus. Quail habitats in this BCR typically are restricted to lower- elevation shrublands and grasslands. Montezuma quail occur along the southern boundary of this BCR and are associated with higher- elevation grassland savannah and chaparral habitats.

California Quail

Current Trend

California quail long-term population trends fluctuate across BCR 16. Changing landscapes affect long-term quail populations. Quail are locally abundant where suitable habitat is present.

Population Estimate Population Density

There is no estimate of California quail population size for BCR 16. Most populations are found in association with brushy riparian corridors, disturbed habitats and agriculture lands.

Desired Population Level

Hunter harvest is used as an index to California quail abundance. The desired population goal would maintain or enhance the current total California quail harvest in BCR 16.

Management Issues Limiting Factors

Landscape changes, such as enhancements in agricultural production (clean- farming methods), degraded riparian conditions due to burning and grazing practices, roads, inappropriate recreational use, invasive plants and urbanization are primary issues limiting California quail populations. Water distribution may be a limiting factor. Domestic and feral cat populations have a negative effect on quail populations particularly in areas near human habitation.

Habitat Objectives

Existing PIF plans, joint venture plans and state wildlife action plans do not specifically address the habitat needs of California quail. However, the implementation of these plans will benefit the species. State game bird management plans discuss California quail habitat needs in varying degrees. Habitat objectives for BCR 16 include:

- Assess existing habitat condition
- Determine and maintain a required residual herbaceous cover height for nesting and brood rearing
- Protect riparian vegetation according to federal regulations
- Identify and maintain minimum distance between water sources in appropriate areas

Management Recommendations

- Use existing imagery and field staff to identify existing and potential habitats and conditions.
- Plan habitat enhancements and improvements at watershed scale.
- Assist land-management agencies and private landowners to identify and implement upland and riparian habitat enhancements.
- Increase native plant diversity in early seral habitats.
- Maintain or increase availability of dense escape and roosting cover.
- Develop riparian wildlife objectives and quail habitat best management practices; incorporate them in Farm Bill conservation program.
- In cooperation with NRCS, develop wildlife consultation services that provide quantified wildlife outputs for that agency's project proposals.
- Maintain vigorous, self-sustaining understory of native grasses and forbs with particular emphasis on allowing seed-set and dispersal to sustain seed-eating wildlife on 10 percent of quail range.
- Maintain site health to keep soil erosion within natural limits on 100 percent of quail range.

- Contact and encourage all local planning authorities to protect quail habitat through appropriate zoning.

- Seek partnerships with landowners, land-management agencies and conservation organizations to protect, maintain and improve habitat for California quail.

- Work with land-management agencies, individuals and conservation organizations to provide water sources for quail and other wildlife. Optimal quail range should have water sources spaced no more than 1.0 mile (1.6 km) apart.

- Where escape cover is lacking, work with land-management agencies and private landowners to provide adequate escape cover, particularly near water sources.

- Manage stands of brush species for diversity of structure and seral-stage and optimal-edges effect.

- Protect riparian areas from inappropriate grazing by livestock, fire and excessive water extraction.

Gambel's Quail

Current Trend

While they occupy a relatively small portion of this region, Gambel's quail apparently are generally stable in BCR 16, with normal annual variation in abundance due to variability in precipitation. In Arizona, Gambel's quail occupy a limited portion of BCR 16, primarily in the western portion of the Arizona Strip, in suitable habitats north of Kingman and along the Colorado River. An isolated population of this species also occurs near Winslow. Gambel's quail numbers have increased in the Arizona Strip portion of the BCR during 2005-2008 in response to above-average winter precipitation. In BCR 16, Gambel's quail also occupy a limited area in Utah along the San Juan and Colorado drainages, in a limited portion of southwestern Colorado, and in suitable habitats in northwestern New Mexico.

Gambel's Quail hunter harvest/Larry Kruckenberg

Population Estimate Population Density

No reliable population estimates exist for this species in BCR 16. Trends in harvest data and a few formal call-count surveys are the primary indices of abundance for Gambel's quail. Breeding bird survey data have been used as an additional trend index, although the data tend to be collected after the peak calling season for this species. Density estimates from this BCR range from 0.11 birds per acre (0.27/ha) in poor years or habitats to 0.39 per acre (0.96/ha) during years of peak abundance. Additional density estimate data is a management need for this species. It is not likely that densities will achieve the maximum.

Desired Population Level

Hunter harvest is used as an index of Gambel's quail abundance. Total harvest in BCR 16 probably averages less than 80,000

Gambel's Quail habitat in Arizona/AGFD

quail annually, although involved states do not collect harvest data at the BCR level and administrative boundaries do not match BCR boundaries. The bulk of this harvest (probably more than 80 percent) is from Arizona. New Mexico contributes the majority of the remaining harvest. The desired population goal would maintain or enhance the current total Gambel's quail harvest level in BCR 16.

Management Issues And Limiting Factors

Unlike other BCRs that are occupied by Gambel's quail, residential and urban development is a less significant threat. Precipitation determine annual abundance, as it does for this species throughout its range.

Habitat Objectives

Habitat recommendations in the Colorado Plateau (Latta et al. 1999) will benefit Gambel's quail, particularly recommendations for habitat protection and acquisition and for noxious weed control. Protection and enhancement of desert wash and riparian habitats are key to this species' survival, as are creation and maintenance of suitable ground cover characteristics and provision of water in more arid habitats. Habitat objectives for BCR 16 include:

- Assess current habitat condition
- Identify and maintain minimum distance between water sources in appropriate areas
- Protect Gambel's quail habitat from further urban development
- Accommodate wildlife movement needs when planning developments
- Develop and implement effective strategies to reduce noxious invasive plant species

Management Recommendations

- Identify and encourage acquisition—by trade, fee-title purchase or conservation easement—of in-holdings within public lands that are of value to Gambel's quail and in danger of development.

- In the more arid portions of this BCR, continued construction and maintenance of artificial waters are critical for Gambel's quail production, distribution and population longevity. This would apply specifically to more arid portions of BCR 16, particularly the western portion of this species' range in Arizona.

- Work with land-management agencies and other entities to reduce harmful, invasive plant species and noxious weeds.

- Restrict off -highway vehicle (OHV) use to existing roads and designated routes In Gambel's quail habitat.

- Conduct feral burro removal in areas this species is negatively impacting. This would include a large portion of the western portion of BCR 16 in Arizona. This recommendation also will benefit other native wildlife.

- Increase the supply of native forbs for use in conjunction with maintaining disturbance of shrubland habitat to compete with the non native invasive species that tend to come in with disturbance.

Scaled Quail

Current Trend

Scaled quail occur within Arizona's portion of BCR 16 but are restricted to a relatively small area along the Little Colorado River (LCR). Little harvest occurs in this area due to low bird abundance and limited distribution. Livestock use has the potential to impact adversely both abundance and distribution of scaled quail in this area. No surveys occur in the Arizona portion of BCR 16 for this species at this time. Scaled quail are most abundant and have the widest distribution in New Mexico's portion of this BCR. Much of the occupied habitat for scaled quail in this area falls within Native American tribal jurisdictions, including the Navajo Nation.

Scaled Quail habitat in Colorado/Ed Gorman

This BCR represents a small fraction of both Arizona (less than 5 percent) and New Mexico scaled quail harvests. The desired population level goal for this BCR is to increase habitat suitability, distribution and abundance so that an annual average harvest of 10,000 can be supported.

Population Estimate Population Density

There are no reliable population estimates for scaled quail in BCR 16. Population indices, such as harvest statistics and breeding bird survey data, are the only current indices available. Refinement of harvest data to

Scaled Quail habitat/Larry Kruckenberg

collect this information at the BCR level is not possible at this time. In Arizona, calling of males is greatly influenced by the timing of precipitation and is so variable during breeding bird survey route surveys that the data may be of little value. Density estimates for scaled quail vary from 0.16 to 1.01 per acre (0.04 -2.5/ha).Since they occupy such a wide variety of habitats throughout their range and since habitat structure varies by region, additional density estimate data at the BCR level is a management need for this species.

Desired Population Level

Hunter harvest will continue to be used as an index of scaled quail abundance in this BCR, although refinement of harvest data (BC-, game management-unit or county-based) and an independent index are management needs. This BCR represents a small fraction of both Arizona (less than 5 percent) and New Mexico scaled quail harvests. The desired population level goal for this BCR is to increase habitat suitability, distribution and abundance so that an annual average harvest of 10,000 can be supported.

Management Issues Limiting Factors

Scaled quail are restricted to areas of the Colorado Plateau's mixed grassland and shrublands along the LCR in Arizona's portion of BCR 16. Past and current livestock- management practices and prolonged drought continue to impact habitat quality and bird abundance in this region. Scaled quail occupy similar areas in New Mexico's portion of the BCR, primarily in grassland habitats below 7,000 feet (2,134 m). Dispersed, semirural subdivisions are increasing in the Arizona portion of this BCR. The impact of this development is undocumented for this species in this area, but issues associated with direct habitat loss and predation by cats and dogs likely have some negative influence on scaled quail.

Habitat Objectives

Implementation of habitat recommendations in "Desert Grasslands" (Latta et al. 1999) will benefit scaled quail and other desert grassland species in this BCR. Also, habitat protection, acquisition and noxious weed control will benefit the species. Protection and enhancement of desert grassland habitats are key to this species' survival, as are creation and maintenance of suitable ground cover. Provision of water developments continues to be debated, but it may benefit this species in more arid portions of its range. Habitat objectives for BCR 16 include:

- Assess current habitat condition
- Continue to assess and address shrub encroachment issues in desert grasslands within this BCR
- Re-establish native bunchgrass habitats where possible

- Identify and maintain minimum distance between water sources in appropriate areas
- Protect existing scaled quail habitat from further urban development

- Accommodate wildlife movement needs when planning developments

- Develop and implement effective strategies to reduce noxious invasive plant species

- Manage livestock levels to accommodate scaled quail.

Management Recommendations

- Institute livestock management practices in BCR 16 that enhance, rather than reduce scaled quail habitats. Livestock- stocking levels should be adjusted in periods of drought to maintain adequate levels of scaled quail habitat.

- Implement annual monitoring throughout the area to assess vegetative condition.

- Convert shrub- invaded grasslands to proper condition. Shrub- reduction programs should be conducted in a manner that increases native forbs and grasses.

- Work with land-management agencies and other entities to reduce harmful invasive plant species and noxious weeds.

- Assess and address identified water-development needs.

- Identify and encourage acquisition—by trade, fee-title purchase or conservation easement—of private lands that are of value to scaled quail and in danger of development.

- Work on legislation to protect state or federal lands in the Southwest from sale, trade or development.

- Work with county and city zoning boards to ensure the needs of this and other wildlife species are met, including considerations for habitat connectivity and adequate patch size.

- Work with county and city zoning boards and land-management agencies to ensure lands remain open to quail hunting. Since sportsmen and sportswomen represent the major funding source for wildlife management in North America, with no foreseeable alternatives, maintaining huntable populations of game species is imperative for stakeholder engagement and continued wildlife conservation and management throughout the United States, Canada and Mexico.

Montezuma Quail

Current Trend

Historical evidence suggests that Montezuma quail were more abundant and widely distributed throughout the southern portion of BCR 16 than they are currently. Recent anecdotal information suggests these quail may be increasing in portions of the BCR due to large-scale wildfires.

Historical evidence suggests that Montezuma quail were more abundant and widely distributed throughout the southern portion of BCR 16 than they are currently. Recent anecdotal information suggests these quail may be increasing in portions of the BCR due to large-scale wildfires.

Population Estimate Population Density

Of all the North American quail species, Montezuma quail are likely the most difficult to detect due to their habits. Outside of harvest monitoring, the most reliable method to estimate abundance or trend is the use of trained pointing dogs. This method is labor and time intensive and is not practical at large scales.

Desired Population Level

Hunter harvest is used to index Montezuma quail abundance. Total harvest in BCR 16 likely represents less than 5 percent of the harvest for this species, the majority of which are taken in Arizona. The population goal for Montezuma quail in this BCR depends on increasing habitat and improving habitat conditions to support an annual harvest of at least 10,000 quail. Most lands are under the jurisdictions of the Bureau of Land Management and Forest Service.

Management Issues Limiting Factors

Limiting factors include the lack of periodic disturbance (fire) in forested habitats necessary to maintain the woodland savannah-like structure Montezuma quail prefer. Most potential habitats in this BCR are dominated by dense stands of ponderosa pine and are currently unsuitable. In addition, grass cover throughout much of this region is inadequate to meet the needs of this species due to grazing pressure by both livestock and elk.

Habitat Objectives

The current distribution and abundance of Montezuma quail in BCR 16 may be increased through manipulation of existing habitats along the Mogollon Rim. Managers should maintain a significant portion of forested habitats in savannah stage and must increase connectivity between isolated populations through increased habitat manipulation. Large- scale wildfires in the late 1990s and early 2000s opened some of the areas along the Mogollon Rim, improving conditions for this species. Active fire management in areas that have experienced large-scale die-offs of pine (both pinyon and ponderosa) due to drought and bark beetles is necessary to reduce the scale of these fires.

Management Recommendations

- For horizontal herbaceous cover, manage grazed lands to maintain greater than 50 percent of horizontal canopy cover of grasses.

- For vertical herbaceous cover (visual obstruction), manage grazed lands to provide greater than 50 percent of canopy cover of grass heights from 8 to 20 inches (20.3–50.8 cm) for escape, nesting, brood-rearing, feeding and roosting cover.

- For native species diversity, maintain or restore to excellent condition those native grasses, forbs and trees best suit to ecological site potential.

- For tree canopy, manage fire and fuel wood programs to maintain a minimum of 25 percent tree canopy cover. Areas with tree canopy of up to 75 percent are frequented by Montezuma quail.

Bird Conservation Region 18: Shortgrass Prairie

(Includes portions of Colorado, Kansas, Oklahoma, Texas and New Mexico)

The Shortgrass Prairie BCR lies in the rain-shadow of the Rocky Mountains, where arid conditions greatly limit the stature and diversity of vegetation. Numerous rivers, such as the Platte River, drain out of the Rocky Mountains through this region and toward the Mississippi Valley. Hydrological simplification has resulted in the invasion of trees and shrubs that support eastern breeding riparian birds. This arid grassland with invading shrubs also is home to scaled quail stretching from the Colorado/Kansas border southward across the Oklahoma panhandle down through eastern New Mexico and the Texas panhandle.

Hunter in Scaled Quail habitat/Larry Kruckenberg

Scaled Quail

Current Trend

Scaled quail populations have been decreasing across this BCR, with the possible exception of southeastern New Mexico. Population declines have been attributed to severe drought and habitat loss due to over grazing or conversion.

Scaled quail are found in huntable numbers in extreme southwestern Kansas in the vicinity of Cimarron National Grassland. In Colorado, they occur in low to high densities within the southern half of BCR 18. Nearly all the occupied scaled quail range in Colorado is deemed agricultural land and primarily used for livestock grazing or non-irrigated crop production. Quail densities are low across much of this area, but high densities can occur anywhere specific habitat types are abundant, including sand-sage rangeland and cholla cactus grasslands. In Oklahoma, the highest populations historically were in the panhandle and counties stretching southward along the Oklahoma/ Texas border. Roadside surveys over the last few years have recorded observations of scaled quail only in Cimarron, Texas, Beaver and Greer counties

of Oklahoma. Scaled quail are found over the extent of BCR 18 in New Mexico and Texas where favorable shrub-grassland exists.

Population Estimates And Population Density

There are no recent reliable population estimates available for scaled quail across this BCR, except for hunter harvest data collected in Colorado and New Mexico. New Mexico's harvest is spread over four regions. Harvest data in Kansas, Oklahoma and Texas are a combination of bobwhite and scaled quail.

Population estimates for two adjacent areas in New Mexico over an eight year period were 0.045 birds per acre (0.11/ha)and (0.85/HA) (Campbell et al. 1973). Schemnitz (1993) reported 0.19 quail per acre (0.47 quail /ha) in 1954 through 1956 compared to 0.9 quail per acre (0.23 quail/ha) in 1991 through 1992 on a 48.3 square mile (125 Km2) area in the Oklahoma panhandle. These estimates are not intended to represent this BCR, but they allow some understanding of populations in two states during the early 1990s. Research into current population levels is an important need in this BCR.

Desired Population Level

Since declining numbers of scaled quail are reported across BCR18, a goal to increase the population to a level comparable to the early 1990s is desirable. The population objective for Colorado is to support an average annual hunter harvest of 12,000 quail by increasing densities within or adjacent to core habitat types.

Management Issues Limiting Factors

Over grazing by livestock, drought and conversion of the shrub/cactus/grassland to straight grassland for grazing or for Conservation Reserve Program lands are central to the density and abundance of scaled quail. Grazing and drought impacts to populations are more harmful in secondary habitats and are less significant in core habitats of sand/sage rangeland and shrub/grasslands. Also, development along the front range in Colorado and elsewhere along with future energy exploration and development may result in additional habitat loss.

Habitat Objectives

Protection and enhancement of existing shrub/grassland, sand/sage rangeland and cholla/grassland communities is key to this species' survival, as well as creation and maintenance of suitable ground cover characteristics. Habitat objectives for BCR 18 include:

- Assess current habitat conditions
- Identify core habitat areas and other areas that can be improved in a cost-effective manner
- Manage livestock grazing to improve the quality and quantity of habitat
- Protect core habitat areas from urban development, widespread crop production and conversion to dense grassland for grazing
- Maintain vegetation communities in early seral stages
- Develop and implement strategies that reduce noxious invasive plant species.

Management Recommendations

- Manage shrub/grassland, sand/sage rangeland, cholla/grassland communities at appropriate levels to maintain or increase suitable habitat in optimum condition. Modify existing livestock grazing to promote suitable habitat conditions .

California Quail habitat/Don Kemner

- Implement annual monitoring to assess grassland condition.

- Provide incentives for private landowners to create habitat for scaled quail.

- Provide incentives for private landowners to open land to public hunting through walk-in access programs.

- Conduct an assessment of scaled quail production, recruitment and annual survival rates, in addition to quail density by habitat type.

- Conduct a review of effective habitat-improvement projects that increase densities of scaled quail without increasing invasive grass or noxious weed communities.

Bird Conservation Region 32: Coastal California

This BCR includes the coastal areas of California, below the northern Pacific rainforest. It also extends into the center part of the state to include the Central Valley. It has a Mediterranean climate of hot, dry summers and cool, moist winters.

California Quail

Current Trend

California quail occur in much of BCR32 where suitable habitat still exists. Breeding bird surveys within California from 1968 to 2003 indicated a generally stable trend. Statewide, the trend in hunter bag as estimated by California's game-take hunter survey, has declined from approximately 1,000,000 in 1992 (the earliest year in which the quail species were segregated in the survey) to approximately 494,000 in 2004. Some of this decline likely is due to a 15-percent drop of upland game bird hunters, indicated by upland game bird stamp sales, during that period.

Population Estimate Population Density

No reliable population estimate is available for this BCR. Densities of California quail in various study sites have been reported by Calkins et al. (1999) as ranging from fewer than or equal to 0.009 bird per acre (0.023/ha) to more than or equal to 0.02 bird per acre (0.05 /ha).

Management issues and limiting factors relative to mountain quail in BCR 32 include loss or fragmentation of habitat through construction of residential areas or other development, limited water in drier locations, lack of structural and seral stage diversity in shrub stands, inappropriate grazing levels, invasion of exotic grass species and degradation of riparian habitat.

Desired Population Level

Since reliable population estimates are not available, harvest by hunters will be used as an index to quail abundance. The game-take hunter survey estimates the number of hunters and take of each species by county. Because this BCR includes only portions of a number of counties, it is difficult to estimate the harvest by hunters. A rough estimate of average, annual harvest in BCR 32 during 2002-2004 was 200,000 birds. The desired population goal will require maintaining or enhancing the existing population level.

Management Issues Limiting Factors

Management issues and limiting factors relative to California quail in this BCR include loss or fragmentation of habitat through construction of residential areas and other development, increasingly intensive agriculture, limited water in drier locations, lack of structural and seral stage diversity in shrub stands, inappropriate grazing levels, invasion of exotic grass species, and degradation of riparian habitat.

Habitat Objectives

Habitat recommendations in the "Coastal Scrub and Chaparral Conservation Plan" (California Partners in Flight 2004) could be expected to be beneficial to California quail, particularly recommendations for habitat protection and acquisition, and for restoration of natural fire regimes that will provide diverse seral stages and structural conditions. Additional habitat objectives have not yet been delineated.

Management Recommendations

- Identify and encourage acquisition—by trade, fee-title purchase or conservation easement—of private lands that are particularly valuable to quail and in danger of conversion to uses that would decrease value as quail habitat.

- Encourage local planning authorities to protect quail habitat through appropriate zoning.

- Seek partnerships with landowners, land-management agencies and conservation organizations to protect, maintain and improve habitat.

- Work with land- management agencies, individuals and conservation organizations, such as Quail Unlimited, to provide water sources for quail and for other wildlife in dry areas. Optimal quail range should have water sources spaced no more than 1 mile (1.6 km) apart.

- Where escape cover is lacking, work with land management agencies and private landowners to provide adequate escape cover, particularly near water sources.

- Manage stands of brush species for diversity of structure, seral stage and optimal edge effect. This may include creation of fire breaks within chaparral stands. Management can be through the use of equipment or fire.

- Manage grazing at appropriate levels to maintain suitable habitat dominated by native species.

- Protect riparian areas from overgrazing by livestock, from fire and from excessive water extraction.

Mountain Quail

Current Trend

Mountain quail occur in a considerable portion of BCR32, although not within the Central Valley or in the immediate vicinity of the coast in southern California. Breeding bird surveys within California for mountain quail showed a stable trend stable from 1968 through 2003. Statewide, the trend in hunter bag as indicated by California's game-take hunter survey, declined from approximately 200,000 in 1992 (earliest year that quail species were segregated in the survey) to approximately 135,000 in 2004. Some of this decrease may be due to a 15- percent drop in upland game hunters in California during that period, as indicated by upland game bird stamp sales.

Population Estimate Population Density

No reliable estimate of population size is available for BCR 32. Densities reported in other locations within mountain quail range may be similar to those within this BCR. Brennan (1990) reported that densities in northern California ranged from (12 -35 quail/km2). Pope (2002) postulated that there were more than 13 per square mile 9 (5 l/ km2) in Hells Canyon and more than 38.9 per square mile (15 /km2) in the southern Cascade Mountains of Oregon.

Desired Population Level

Since reliable population estimates are not available, estimated harvest by hunters is used as an index to quail abundance. The game-take hunter survey estimates the number of hunters and take of each species by county. A rough estimate of the average annual harvest in this BCR during the years 2002, 2003 and 2004 is 17,000 mountain quail. The desired population goal is to maintain or enhance the existing population level as measured by the harvest by hunters.

Management Issues Limiting Factors

Management issues and limiting factors relative to mountain quail in BCR 32 include loss or fragmentation of habitat through construction of residential areas or other development, limited water in drier locations, lack of structural and seral stage diversity in shrub stands, inappropriate grazing levels, invasion of exotic grass species and degradation of riparian habitat.

Habitat Objectives

Habitat recommendation in "Coastal Scrub and Chaparral Conservation Plan" (California Partners in Flight 2004) could be expected to be beneficial to mountain quail, including recommendations for habitat protection and acquisition, and for restoration of natural fire regimes that will provide diverse seral stages and structural conditions. In addition, a bird- conservation plan specifically directed at mountain quail has been prepared in conjunction with this conservation plan. Some management issues and concerns listed in that plan are incorporated into the management recommendations listed below.

Management Recommendations

- Identify and encourage acquisition—by trade, fee-title purchase or conservation easement—private lands that are of value to mountain quail, and in danger of being developed. Summer and winter ranges, as well as corridors between them, should be considered.

- Encourage local planning authorities to protect habitat through appropriate zoning.

- Seek partnerships with landowners, land-management agencies and conservation organizations to protect, maintain and improve habitat.

- Work with land-management agencies, individuals, and conservation organizations (such as Quail Unlimited) to provide water sources for quail and other wildlife in dry areas. Optimal quail range should have water sources spaced no more than 1 mile (1.6 km) apart.

- Manage stands of brush species for diversity of structure and seral stage, and optimal edge effect. This may include creation of fire breaks within chaparral stands. Management can be through the use of equipment or fire.

- Manage grazing at appropriate levels that result in the maintenance of suitable escape cover and some areas of habitat dominated by forbs, rather than annual grasses.

- Protect riparian areas from overgrazing by livestock, fire and excessive water extraction.

- Where feasible, provide source stock to other states to help their efforts to re-establish mountain quail.

Mountain Quail habitat in California/CDFG

Gambel's Quail desert habitat/Larry Kruckenberg

Bird Conservation Region 33: Sonoran and Mohave Desert

(Includes portions of Arizona, Nevada and California)

The Mohave Desert covers southeastern California and southern Nevada and adjoins the Sonoran Desert, which extends from southwestern Arizona southward on both sides of the Gulf of California into the Mexican states of Baja California, Sonora and Sinaloa. This arid region is dominated by cacti, grasses, creosote bush and other desert shrubs. Riparian habitats provide habitat critical for Gambel's quail. Sonoran upland habitats in the east-central portion of this BCR (central Arizona) produce the greatest densities of Gambel's quail in the world. Although the ranges of mountain quail and California quail may extend into the extreme western portion of this BCR, Gambel's quail are the focus here.

Gambel's Quail

Current Trend

This BCR, coupled with BCR 34 to the east, likely contains more than 90 percent of the world's population of Gambel's quail. The trend for this species is considered to be stable at this time, although abundance likely

was much higher in the past, prior to major water diversions for agriculture and riparian degradation.

Population Estimate And Population Density

No reliable population estimates exist for this species in BCR 33. Trends in harvest data and a few formal call-count surveys are the primary indices of abundance for Gambel's quail. Breeding bird survey data have been used as an additional trend index, but the data tend to be collected after the peak calling season for this species. Density estimates from this BCR range from 0.11 birds per acre (0.27/ha) in poor years or habitats to 1.20 birds per acre (2.96/ha) during years of peak abundance. Additional density estimate data is a management need for this species.

Desired Population Level

Hunter harvest is used as an index of Gambel's quail abundance. Total average harvest in BCR 33 is roughly 700,000. The bulk of this harvest is from Arizona (approximately 600,000). California and Nevada contribute around 55,000 and 45,000 to this total annually. The desired population goal would maintain or enhance the current total Gambel's quail harvest level in BCR 33.

Protection and enhancement of desert wash and riparian habitats are key to this species survival, as are creation and maintenance of suitable ground cover characteristics and provision of water in more arid habitats.

Management Issues Limiting Factors

The biggest threat to Gambel's quail is the rate at which the desert Southwest is being developed and the alarmingly rapid human population growth. In Arizona, a significant portion of occupied Gambel's quail habitat has been or is facing the threat of urban development. Continued development will have adverse impacts on species' distribution, abundance and harvest opportunity. Conversion of Mojave desert shrub/scrub with invasive annual grasses due to large scale wildfires also is a serious threat.

Habitat Objectives

Habitat recommendations for habitat protection and acquisition and for noxious weed control will benefit Gambel's quail and are consistent with recommendations for other species in BCR 33 (Latta et al. 1999). Protection and enhancement of desert wash and riparian habitats are key to this species survival, as are creation and maintenance of suitable ground cover characteristics and provision of water in more arid habitats. Habitat objectives for BCR 33 include:

- Assess current habitat condition
- Identify and maintain minimum distance between water sources in appropriate areas
- Protect existing Gambel's quail habitat in this BCR from further urban development
- Accommodate wildlife movement needs when planning developments
- Develop and implement effective strategies to reduce red brome and other noxious invasive plant species.

Management Recommendations

- Identify and encourage acquisition—by trade, fee-title purchase or conservation easement—of in-holdings within public lands that are of value to Gambel's quail and in danger of development.

- Work on legislation to protect state or federal lands in the Southwest from sale, trade or development. In Arizona, areas between Phoenix and Tucson and between Phoenix and Kingman are particularly vulnerable to development at a vast scale. In Nevada, sprawl around Las Vegas consumes quality quail habitat. These areas represent some of the most rapidly growing portions of the United States. These lands also represent a large percentage of core range for Gambel's quail.

- Work with county and city zoning boards to ensure the needs of Gambel's quail and other wildlife species are met, including considerations for habitat connectivity and adequate patch size.

- Work with county and city zoning boards and land-management agencies to ensure lands remain open to quail hunting.

- In the more- arid portions of BCR33, continued construction and maintenance of artificial waters are critical for Gambel's quail production, distribution and population longevity. This would include the western portion of this species' range in Arizona and the majority of occupied Gambel's quail habitat in California and Nevada.

- Work with land-management agencies and other entities to reduce harmful, invasive, plant species and noxious weeds, with particular emphasis on control or eradication of Saharan mustard and red brome in BCR 33.

The biggest threat to Gambel's quail is the rate at which the desert Southwest is being developed and the alarmingly rapid human population growth. In Arizona, a significant portion of occupied Gambel's quail habitat has been or is facing the threat of urban development.

- Provide OHV users with areas that are currently poor wildlife habitat to conduct their activities. In other areas, restrict OHV use to existing roads and designated routes. Provide law enforcement to address specifically resource concerns involving OHV users.

- Conduct feral burro removal in areas this species is negatively impacting. This would include a large portion of the western half of BCR 33 in Arizona. This recommendation will benefit Gambel's quail, and other native Sonoran and Mojave Desert species.

Masked Bobwhite

Current Trend

While no rangewide survey information exists, masked bobwhite populations have declined in central Sonora and on the Buenos Aires National Wildlife Refuge.

Population Estimate Population Density

No reliable estimate of population numbers exists. However, population levels appear to be extremely low, perhaps nearing extinction.

Desired Population Level

The Masked Bobwhite Recovery Plan (U.S. Fish and Wildlife Service 1995) considers the subspecies to be re-established when a population of at least 500 masked bobwhite inhabit the Buenos Aires National Wildlife Refuge. At that point, a second site would be selected for the reintroduction of a second population.

In Sonora, the emphasis is on preserving and restoring two or more viable populations. Downlisting from endangered to threatened status would be considered when four separate, viable populations are established (two in the United States and two in Mexico). They also would have to be maintained for 10 consecutive years.

Management Issues And Limiting Factors

Issues pertinent to the establishment of viable populations in Arizona include prolonged drought, invasion of velvet mesquite, prevalence and invasiveness of nonnative grasses (particularly Lehmanns' lovegrass), lack of diversity of leguminous shrubs, and lack of winter rain. In addition, extremely high densities of predators (avian, mammalian and reptilian) may be contributing to low population densities.

Sonoran issues are integrally related to extreme drought coupled with continued heavy cattle grazing and the planting of buffelgrass for cattle forage. This has resulted in loss of plant diversity and, ultimately, bobwhite habitat.

Habitat Objectives

Habitat objectives for BCR 33 include:

- Assess habitat conditions
- Reduce mesquite encroachment in desert grasslands
- Reduce nonnative grasses
- Re-establish native perennial bunchgrasses
- Establish native food plants, such as leguminous shrubs and native forbs
- Provide adequate hiding, thermal and nesting cover, either through native plants or through artificial means, such as brush piles
- Assess water distribution and to provide for water needs as necessary
- Assure adequate interspersion of food, cover and water needed by masked bobwhites
- Create or maintain stands of vegetation consisting of 15- to 30 percent woody vegetation, at least 15 percent forb cover, at least 15 percent native grass cover and between 0- and 25 percent unobstructed bare ground
- Create or maintain diverse stands of native vegetation consisting of a minimum of 8 native perennial grass species, a minimum of 12 perennial forb species and a minimum of 3 midstory shrub or tree species
- Manage livestock stocking rates and grazing regimes to permit coexistence of livestock and masked bobwhite.

Management Recommendations

Arizona

- Utilize prescribed fire to stimulate growth of forbs and seed-producing plants.
- Plant appropriate food or cover plants. Implement traditional habitat-management

techniques, such as disking, mowing and aeration to improve production of food plants.

- Create brush piles or implement half-cutting to improve cover where needed.

- Provide water catchments with access and escape ramps wherever needed.
- Reduce cover of nonnative grasses and noxious weeds.

- Assess the predator base and implement reduction, if needed.

Mexico

- Establish conservation easements or purchase ranches in core bobwhite areas.

- Provide for movement corridors between populations.

- Reduce buffelgrass and re-establish native grass.

- Provide for water catchments in extremely arid areas.

- Reduce or eliminate grazing and the development of rotational grazing systems for livestock in core bobwhite areas.

- Plant appropriate food or cover plants where needed.

- Implement disking, mowing, aeration and, possibly, prescribed fire to improve production of food plants.

- Support continued predator reductions if needed.

Bird Conservation Region 34: Sierra Madre Occidentail

(Includes portions of Arizona and New Mexico)

The Sierra Madre Occidental mountain range runs northwest to southeast parallel to the Pacific Coast, from the Mogollon Rim and isolated mountain ranges in southeastern Arizona and southwestern New Mexico through Sonora to central Mexico. It is characterized by high elevations and a complex topography with the presence of oak/pine, pine and fir forests along the mountain range and of semiarid scrub habitats on eastern slopes. Most uplands in the United States portion of BCR 34 are publicly owned, but lower-elevation grasslands and riparian habitat are subject to development and conversion. The whole region is an important corridor for migration of many species in the West.

Montezuma Quail/Larry Kruckenberg

Montezuma Quail

Current Trend

Current management of the majority of the Montezuma quail habitats in this BCR provide for a stable, overall trend in abundance, with annual variation due to precipitation patterns. The majority of Montezuma quail habitats in this BCR fall under the jurisdiction of the Coronado National Forest.

Population Estimate Population Density

No reliable population estimates exist for this species. Of all the North American quail species, Montezuma quail likely are the most difficult to detect and survey due to their secretive habits.

Desired Population Level

Hunter effort and harvest will continue to be used as indices of Montezuma quail abundance. Total harvest in BCR 34 currently likely represents 90 percent of the harvest for this species; the majority of which are taken in Arizona. The desired population goal for Montezuma quail in BCR 34 is to maintain or improve habitat and abundance so that this population can support an average sustained harvest of at least 30,000 quail annually.

Management Issues Limiting Factors

Limiting factors for this species in BCR 34 primarily involve precipitation and grass cover height. Livestock grazing has been a significant concern in this area in the past, but has lessened in recent years with the adoption of the Montezuma quail habitat guidelines by the Coronado National Forest.

Habitat Objectives

The current distribution and abundance of Montezuma quail in BCR 34 will be maintained through continued application of the Montezuma quail habitat guidelines by the Coronado National Forest. Habitat objectives for BCR 34 include:

- Continue to apply the Montezuma quail habitat guidelines throughout potential and occupied habitats
- Adjust livestock use downward during drought years, so the grass cover needs of this species are met
- Monitor and map invasive grass distribution
- Develop control strategies and to manage invasive grass species to reduce their distribution
- Convert potential Montezuma quail habitat areas with invasive grasses to native bunchgrass habitats

Management Recommendations

- Manage grazed lands to maintain greater than 50 percent as horizontal canopy cover of grass.

Gambel's Quail habitat in New Mexico/Larry Kamees, NMDGF

- Manage grazed lands in Montezuma quail habitat to provide greater than 50 percent canopy cover of grass heights from 8 to 20 inches (20.3–50.8 cm) for escape, nesting, brood- rearing and roosting cover.

- Manage grazed lands habitat to maintain or improve species richness.

- Maintain or restore at least five native perennial bunchgrass species. Native forb and tree species diversity should be maintained or enhanced.

- Maintain the necessary security and thermal cover and the necessary microclimate for the forbs on which Montezuma quail feed. Manage fire and fuelwood programs to maintain a minimum of 25- percent tree canopy cover. Areas with tree canopy of up to 75 percent are frequented by Montezuma quail.

Gambel's Quail

Current Trend

While Gambel's quail does not reach the abundance found in BCR 33, they still are common throughout much of the lower elevations found in BCR34. Recent droughts, particularly during winter months, have reduced overall numbers of Gambel's quail. A return to more normal precipitation will increase abundance, provided habitat is protected from conversion.

The biggest threat to Gambel's quail is the rate at which the desert Southwest is being developed and the rapid human population growth. In Arizona, a large portion of occupied Gambel's quail habitat has been facing the threat of urban development. Continued development will have major impacts on the species distribution, abundance and harvest opportunity.

Population Estimate Population Density

No reliable population estimates exist for this species in BCR 34. Trends in hunter harvest data and a few formal call-count surveys are the primary indices of abundance for Gambel's quail. Breeding bird survey data have been used as an additional trend index, although the data tend to be collected after the peak calling season for this species. Documented density estimates range from 0.11 bird per acre (0.27/ha) in poor years or habitats to 1.19 birds per acre (2.96/ha) during years of peak abundance. Additional density estimate data are a management need for this species.

Desired Population Level

Hunter harvest issued as an index of Gambel's quail abundance. Total average annual harvest in BCR 34 is roughly 100,000. The bulk of which is taken in Arizona . New Mexico contributes a small percentage of annual harvest in this BCR. The desired population level would maintain or enhance the current total Gambel's quail harvest in BCR 33.

Management Issues Limiting Factors

The biggest threat to Gambel's quail is the rate at which the desert Southwest is being developed and the rapid human population growth. In Arizona, a large portion of occupied Gambel's quail habitat has been facing the threat of urban development. Continued development will have major impacts on the species distribution, abundance and harvest opportunity.

Habitat Objectives

Habitat recommendations, made by PIF, for Sonoran desert scrub will benefit Gambel's quail, as will recommendations for general habitat protection and acquisition and noxious weed control. Protection and enhancement of desert wash and riparian habitats are key to this species survival, as is creation and maintenance of suitable ground cover characteristics. Habitat objectives for BCR 34 include:

- Assess current habitat condition

- Identify and maintain minimum distance between water sources in appropriate areas; much of this area will require little additional water

- Protect existing Gambel's quail habitat in this BCR from further urban development

- Accommodate wildlife movement needs when planning developments

- Develop and implement effective strategies to reduce noxious invasive plant species

Management Recommendations

- Identify and encourage acquisition—by trade, fee-title purchase or conservation easement—of in-holdings within public lands that are of value to Gambel's quail and in danger of development.

- Work on legislation to protect state or federal lands in from sale, trade or development. In Arizona, areas between Phoenix and Tucson are particularly vulnerable to further development at a vast scale, and they represent one of the most rapidly growing segments of the United States. These lands represent a large percentage of core range for Gambel's quail and for other Sonoran Desert species.

- Work with county and city zoning boards to ensure that the needs of Gambel's quail and other wildlife species are met, including

considerations for habitat connectivity and adequate patch size.

- Work with county and city zoning boards and land-management agencies to ensure lands remain open to quail hunting.

- Work with land-management agencies and other entities to reduce harmful invasive plant species and noxious weeds, with particular emphasis on control and eradication of certain species such as Lehmann's lovegrass and buffelgrass.

- Provide OHV users with areas that are poor wildlife habitat to conduct their activities. In other areas, restrict OHV use to existing roads and designated routes. Increase law enforcement to address resource concerns involving OHV users.

Scaled Quail

Current Trend

Scaled quail apparently are declining throughout their range in response to habitat type conversions. Scaled quail abundance and distribution in Arizona is greatest in BCR 34. These birds are associated with Chihuahuan Desert grasslands of southeastern Arizona, particularly in the Sulphur Springs and San Bernardino Valleys. Scaled quail also remain relatively common in suitable habitats east of Tucson, near the towns of Sonoita and Tombstone, and the Buenos Aires National Wildlife Refuge. The population of scaled quail found north of Oracle has declined dramatically due to habitat conversion. This population will likely be extirpated relatively soon due to planned developments in the area.

Population Estimate Population Density

There are no reliable population estimates for scaled quail in BCR 34. Harvest statistics

Scaled Quail in New Mexico/NMDG&F

and breeding bird survey data are the only current population indices available. Calling of males is greatly influenced by spring and summer precipitation levels and is so variable that these data may be of little value. Density estimates for scaled quail vary from 0.016 to 1.01 per acre (0.04 to 2.50/ha). Additional density estimate data area management need for this species in BCR 34.

Desired Population Level

Hunter harvest will continue to be used as an index of scaled quail abundance in this BCR, although an independent index is a management need. This BCR represents the bulk of scaled quail harvest in Arizona, probably in excess of 95 percent. Average annual harvest since 1991 is around 47,000, but has averaged significantly lower

Human development is increasingly reducing habitat availability for this scaled quail but at a lower rate than for Gambel's quail. Invasive grass species and reduction of native perennial bunchgrass also negatively impacts the species.

(approximately 30,000) in recent years. The desired population goal for this BCR is to increase habitat suitability and abundance, so an annual average harvest of 45,000 can be supported.

Management Issues Limiting Factors

The major limiting factors for this species involve drought and overuse of Chihuahuan grasslands by livestock and corresponding type conversion (grassland to shrublands). Human development is increasingly reducing habitat availability for this scaled quail but at a lower rate than for Gambel's quail. Invasive grass species and reduction of native perennial bunchgrass also negatively impacts the species.

Habitat Objectives

Habitat recommendations to benefit scaled quail and other desert grassland species in BCR 34 are provided in Latta et al. (1999). Additional recommendations follow. Protection and enhancement of desert grassland habitats are key to this species survival, as are creation and maintenance of suitable ground cover characteristics. Provision of water developments continues to be debated but may benefit this species in more- arid portions of its range. Habitat objectives for BCR 34 include:

- Assess current habitat condition
- Continue to assess and address shrub encroachment in the Sulphur Springs and San Bernardino valleys
- Reestablish native bunchgrass habitats where possible
- Identify and maintain minimum distance between water sources in appropriate areas
- Protect existing scaled quail habitat in this BCR from further urban development
- Accommodate wildlife movement needs when planning developments
- Develop and implement effective strategies to reduce noxious invasive plant species
- Manage livestock levels to accommodate scaled quail

Management Recommendations

- Manage shrub and grassland components at appropriate levels to maintain existing suitable habitat.
- Modify existing livestock grazing to promote habitat conditions. Implement annual vegetation monitoring throughout the area to assess condition.
- Convert shrub-invaded grassland to proper condition. Shrub-reduction programs should be conducted in a manner that does not increase non-native invasive grasses.
- Work with land-management agencies and with other entities to reduce harmful invasive plant species and noxious weeds,

with particular emphasis on control and eradication of species such as Lehmann's lovegrass and buffelgrass.

- Assess and address identified water-development needs.

- Identify and encourage acquisition—by trade, fee-title purchase or conservation easement—of private lands that are of value to scaled quail and in danger of development.

- Work on legislation to protect state or federal lands in the Southwest from sale, trade or development.

- Work with county and city zoning boards to ensure the needs of this and other wildlife species are met, including considerations for habitat connectivity and adequate patch size.

- Work with county and city zoning boards and with land-management agencies to ensure lands remain open to quail hunting

Masked Bobwhite

Current Trend

While no range-wide survey information exists, masked bobwhite populations have declined in central Sonora and on the Buenos Aires National Wildlife Refuge.

Population Estimate Population Density

No good estimate of population numbers exists. However, population levels appear to be extremely low, perhaps nearing extinction.

Desired Population Level

The Masked Bobwhite Recovery Plan (U.S. Fish and Wildlife Service 1995) considers the subspecies to be re-established when a population of at least 500 masked bobwhites inhabit the Buenos Aires National Wildlife Refuge. At that point, a second site would be selected for the reintroduction of a second population.

Extremely high densities of predators (avian, mammalian and reptilian) may be contributing to low population densities.

In Sonora, the emphasis is on preserving and restoring two or more viable populations. Downlisting from endangered to threatened status would be considered when four separate, viable populations are established (two in the United States and two in Mexico). They also would have to be maintained for 10 consecutive years.

Management Issues Limiting Factors

Issues pertinent to the establishment of viable populations in Arizona include prolonged drought, invasion of velvet mesquite, prevalence and invasiveness of nonnative grasses (particularly Lehmann's lovegrass), lack of diversity of leguminous shrubs, and lack of winter rain. In addition, extremely high densities of predators (avian, mammalian and reptilian) may be contributing to low population densities.

Sonoran issues are integrally related to extreme drought coupled with continued cattle grazing and the planting of buffelgrass for cattle forage. This has resulted in loss of plant diversity and, ultimately, bobwhite habitat.

Habitat Objectives

Objectives for BCR 34 include:

- Assess habitat conditions
- Reduce mesquite encroachment in desert grasslands
- Reduce nonnative grasses
- Re-establish native perennial bunchgrasses
- Establish native food plants, such as leguminous shrubs and native forbs
- Provide adequate hiding, thermal and nesting cover, either through native plants or artificial means, such as brush piles
- Assess water distribution and provide for water needs as necessary
- Assure adequate interspersion of food, cover and water needed
- Create or maintain stands of vegetation consisting of 15- 30 percent woody vegetation, at least 15 percent forb cover, at least 15 percent native grass cover and between 0- 25 percent unobstructed bare ground
- Create or maintain diverse stands of native vegetation consisting of a minimum of 8 native perennial grass species, a minimum of 12 perennial forb species and a minimum of 3 midstory shrub or tree species
- Manage livestock stocking rates and grazing regimes to permit co-existence of livestock and masked bobwhite

Management Recommendations

Arizona

- Utilize prescribed fire to stimulate growth of forbs and seed-producing plants.
- Plant appropriate food or cover plants.
- Implement traditional habitat management techniques, such as disking, mowing and aeration to improve production of food plants.
- Create brush- piles or implement half-cutting to improve cover where needed.
- Provide and maintain water catchments and spreader dams wherever needed.
- Reduce cover of nonnative grasses and noxious weeds.
- Assess the predator base and implement reduction, if needed.

Mexico

- Establish conservation easements or purchase ranches in core bobwhite areas.
- Provide for movement corridors between populations.
- Reduce buffelgrass and re-establish native grass.
- Provide for water catchments in extremely arid areas.
- Reduce or eliminate grazing and the development of rotational grazing systems for livestock in core bobwhite areas.
- Plant appropriate food or cover plants where needed.

- Implement disking, mowing, aeration and, possibly, prescribed fire to improve production of food plants.

- Support continued predator reductions if needed.

Bird Conservation Region 35: Chihuahuan Desert

(Includes portions of Texas and New Mexico)

The Chihuahuan Desert stretches from the Madrean Mountains on the west to the Edwards Plateau in Texas, grades into the Southern Great Plains to the north and extends over much of the central Mexican Plateau. Arid grassland and shrubland cover broad basins and higher- elevation oak/ juniper woodland and conifers occur in numerous mesas and mountains.

Gambel's Quail

Most Gambel's quail in this BCR occupy the southern portion of New Mexico. Small populations of Gambel's quail exist along the Rio Grande Valley in Texas, but this account will focus on the prime range in New Mexico.

Current trend

While this species does not reach the abundance found in BCR 33, Gambel's quail are still common throughout much of the lower elevations found in the BCR. Recent droughts, particularly during winter months, have reduced overall numbers of Gambel's quail in BCR 35. A return to more normal precipitation will increase abundance, provided habitat is protected from conversion.

Population Estimate Population Density

No reliable population estimates exist for this species in BCR 34. Trends in harvest data and a few formal call-count surveys are the primary indices of abundance for Gambel's quail. Breeding bird survey data have been used as an additional trend index; although, the data tends to be collected after the peak calling season for this species. Documented density estimates range from 0.11 per acre (0.27/ha) in poor years or habitats to 1.2 per acre (2.96/ha) during years of peak abundance. Additional density estimate data is a management need for this species.

Desired Population Level

The current Gambel's' quail population level must be maintained or increased.

Management Issues Limiting Factors

The major threat to Gambel's' quail in both New Mexico and Texas is the conversion of mesquite-grassland habitat to both open grassland and development. Overgrazing

Gambel's Quails/Larry Kruckenberg

is also a factor in declining populations of Gambel's quail.

Habitat Objectives

Protection and enhancement of desert wash and riparian habitats are key to this species survival, as is creation and maintenance of suitable ground cover characteristics. Habitat objectives for BCR 35 include:

- Access current habitat conditions
- Identify and maintain minimum distance between water sources in appropriate areas
- Protect existing riparian habitats from further destruction or development
- Develop and implement effective strategies to reduce noxious, invasive plant species

Management Recommendations

- Identify key riparian habitats and protect them through conservation easement, fee title purchase or federal rangeland protection incentives to private landowners.
- Work with county and city zoning boards to ensure the needs of quail and other wildlife species are met, including considerations for habitat connectivity and adequate patch size.
- Work with county, city and land-management agencies to ensure lands remain open to quail hunting.
- Work with land-management agencies and with other entities to reduce harmful invasive plant species and noxious weeds.

Scaled Quail

Current Trend

Scaled quail are associated with Chihuahuan Desert grasslands in southern New Mexico and southwestern Texas. Populations have been declining throughout BCR35. Scaled quail still remain common in early seral stage shrublands in Texas and the mesquite-grasslands of southern New Mexico. Scaled quail numbers appear to have suffered higher declines in overgrazed areas and in places where more climax shrub communities exist.

Population Estimate And Population Density

There are no recent reliable population estimates for scaled quail in BCR 35. Population indices, such as harvest statistics, breeding bird survey, and Christmas Bird Count trend data are the only current indices available. Density estimates for current populations are lacking and remain a very important management need. Population estimates for two adjacent areas in New Mexico over an eight year period were 0.045 quail per acre (0.11/ha) and 0.035 per acre (0.085/ha). (Campbell et al. 1973).

Desired Population Level

Hunter harvest is the only index to estimate quail abundance in this BCR. The harvest

estimates from New Mexico are split between BCR 35 and BCR 18 (shortgrass prairie). There are no data specifically on scaled quail harvest in Texas; they are recorded along with bobwhite quail in the harvest statistics. A reasonable population goal would be to achieve population levels in New Mexico that would produce a harvest of 150,000 birds, as occurred in the early 1990s and in 1999.

Management Issues Limiting Factors

The limiting factors for this species involve drought, overgrazing by grasslands and conversion of shrub-grassland landscape to grassland only or to one dominated by dense scrub. The effects of invasive grass species and reduction of native bunch grasses also negatively impact this species.

Habitat Objectives

Habitat recommendations call for maintaining mesquite-grassland and early to mid-successional stages of shrub-grassland communities. Protection and enhancement of these habitats are key to scaled quail survival, as are creation and maintenance of suitable ground cover characteristics. Provision of water development continues to be debated but may benefit this species in arid portions of its range if only by better distribution of grazing. Habitat objectives for BCR 35 include:

- Assess current habitat conditions
- Maintain or improve early seral stage of shrub-grasslands dominated by forbs and shrubs
- Re-establish native bunch grass habitats where possible
- Identify and maintain minimum distance between water sources in appropriate areas
- Develop and implement effective strategies to reduce noxious invasive plant species
- Manage livestock levels to accommodate scaled quail needs

Management Recommendations

- Manage shrub-grassland community at appropriate levels to maintain existing suitable habitat.
- Modify existing livestock grazing to promote habitat conditions.
- Implement annual monitoring throughout the area to assess grassland condition.
- Convert shrub-invaded grasslands to preferred shrub-grassland condition.
- Assess and address identified water development needs.
- Identify and encourage acquisition by trade, fee title purchase or conservation easement of private lands that are of value to scaled quail and in danger of development.
- Work on legislation to protect state and federal lands in the Southwest from sale, trade or development.
- Work with county and city zoning boards and with land-management agencies to ensure lands remain open to hunting.

Recommended
Management Practices

Mountain Quail habitat in Washington/Lisa Cross

Land Management Planning

- Step down management recommendations to establish specific targets within public land- management plan.

Land Management Practices

- Assess and recommend grazing management that benefits quail, such as deferment, rotation or rest.

- Maintain appropriate animal unit months (AUMs) on occupied quail range.

- Manage shrub and grassland component appropriate for scaled quail.

- Manage for early seral brush component for California quail and Montezuma quail.

- Maintain savanna characteristics in Madrean Archipelago for Montezuma quail.

- Increase dense roost site habitats for California quail.

- Restore native vegetation to riparian corridors by (a) controlling invasive plant species, e.g., saltcedar, leafy spurge, (b) managing forage removal and (c) planting native species.

- Manage dense brush stands for diversity of stand density and edge effect to benefit California quail and Montezuma quail by establishing fire lanes in chaparral and scrub oak habitats.

- For all quail species, maintain and encourage native plants that provide critical invertebrate food sources for developing chicks.

- Develop Best Management Practices for "quail friendly" habitat treatment and incorporate them into land -use plans of public land managers, and farm bill conservation programs.

Invasive Species Management

- Control and prevent invasive annual grasses and noxious weeds.

- In appropriate habitats, encourage the use of prescribed fire or create let-burn policies, especially in mountain quail habitats. Managers should not use fire as a habitat-management tool when there is a risk of invasive species out-competing desired native vegetation unless active measures, such as spraying, are planned in order to control invasive plants.

- Feral hog control may be an important management practice in some quail ranges.

Conservation Programs

- Develop education programs and materials for the public regarding quail and the protection and enhancement of quail habitat.

- Take advantage of existing federal (e.g., farm bill) programs.

- Seek partnerships with landowners, land-management agencies and nongovernment organizations (such as Quail Unlimited, Quail Forever and watershed councils) to improve quail habitat.

- Encourage community efforts to consider natural resource needs.

- Complete spatially mapping current distribution (occupied habitat) of each western quail species.

- Assess indices to population abundance that can replace harvest trends in those locations without regulated hunting seasons.

- Work with USDA native plant material centers to collect, store and develop new native plant stock for quail habitat. Identify remaining patches of quail habitat to serve as areas for collection of native seeds.

- Identify remaining patches of excellent quail habitat to serve as benchmarks for comparing and measuring success of habitat treatments.

Water Distribution and Allocation Policy

- Restore riparian areas.

- Restore seeps and springs.

- Develop and maintain natural ponds and artificial water sources (such as guzzlers and catchments) where needed.

- Provide both access ramps and escape ramps to existing watering facilities.

Mountain Quail habitat in Oregon/Michael Pope

- Mitigate for over allocation of water resources.

Development Policy

- Encourage backyard habitat in urban settings.

- Ensure zoning and planning considers needs of wildlife.

- Encourage protection of farm and ranch lands.

Fragmentation Policy

- Create riparian corridors with associated vegetation.

- Improve connectivity of existing riparian corridors and shrub communities.

Harvest Policy

- Identify quail hunters to increase accuracy of harvest surveys.

- Structure hunting regulations to account for differences in distribution and population size

- Collect hunter- harvest information (e.g., wing collection).

Disturbance

- Manage dog training and trials, so impacts to reproducing quail are eliminated or reduced.

- Work with land-management agencies to manage OHV use to limit damage to habitat. Educate OHV users about impacts to quail and quail habitat.

- Restrict OHV use to designated trails.

Translocations

- Support intra- and interstate efforts to restore quail populations to suitable habitats.

Predators

- Reduce or eliminate feral mammals.

Research Needs

Monitoring Protocol Development

- Continue to develop and refine reliable population indices that are independent of harvest data (e.g., call counts, pointing dog surveys, brood counts).

Population Dynamics

- Determine the benefit of free-standing water to quail throughout the year. Discover whether the addition of artificial water sources benefits quail populations.

- Find out how Montezuma quail survive in the high-elevation habitats of BCR 16 and 34.

- Learn whether seasonal migration occurs and, if so, what distances are traveled.

- Continue to update basic life-history knowledge for all western quail species.

- Assess quail density potential by habitat type and BCR.

Harvest Policy

- Refine harvest- survey techniques and apply them consistently throughout a species' range.

- Ascertain how late-season hunting affects breeding populations.

- Determine how hunting seasons affect bird abundance.

Predation Policy

- Conduct research into the effects of predation.

Habitat Policy

- Develop a habitat-assessment model in xeric landscapes for mountain quail.

- Conduct research regarding the effects of fire for various habitat types by species.

- Conduct research regarding the effects of timber production and harvest on quail species.

- Conduct research regarding the effects of grazing in various habitat types.

Translocation Policy

- Evaluate release techniques.

- Evaluate source population survival in various habitats.

- Evaluate various trapping techniques by species.

Recreational Use of Habitat

- Quantify effects of OHV use.

Development of Habitat

- Quantify the impacts of both urban and semi-urban developments.

Desert habitat/Larry Kruckenberg

Climate Change

- Responses of western quail to decreases in precipitation and increases in temperature need to be understood better.

Implementation

- Development of priority actions for funding (e.g., scaled quail and mountain quail habitats, consistent harvest data collection, implementation of individual state plans, etc).

- Develop metrics and methods to track accomplishments of the Plan.

Review and Update Process

- Recommend this plan be continuously reviewed and updated, with scheduled five year reviews.

Literature Cited

Anderson, W. L. 1974. Scaled quail: Social organization and movements. Thesis. University of Arizona, Tucson,

Arrington, O. N. 1942. A survey of possible refuge areas for masked bobwhite in the Arivaca and Altar Valleys: Special report project 110. Arizona Game and Fish Commission, Phoenix.

Bauer, O. 1977. Improving land for California valley quail, leaflet number 8. California Department of Fish and Game, Sacramento.

Beck, J. L., K. P. Reese, P. Zager and P. E. Heekin. 2005. Simultaneous multiple clutches and female breeding success in mountain quail. Condor107:891–9.

Bendire, C. 1892. Life histories of North American birds: Special bulletin—U.S. Natural Museum 3. Smithsonian Institution Washington, DC.

Bishop, R. A. 1964. The Mearns' quail *"Cyrtonyx montezumae mearnsi"* in southern Arizona. Thesis. University of Arizona, Tucson.

Bishop, R. A., and C. R. Hungerford. 1965. Seasonal food selection of Arizona Mearns' quail. J. Wild. Manage, 29:813–9.

Blakely, K. L., J. A. Crawford, R. M. Oats, and K. M. Kilbride. 1988. Invertebrate matter in the diet of California quail in western Oregon. Murrelet 69:75–8.

Brennan, L. A. 1990. What happened to the Mountain quail in Idaho? Quail Unlimited Mag. 42–43.

_____. 1993. Broad-scale population declines in four species of North American quail: An examination of possible causes. In Sustainable ecological systems: Implementing an ecological approach to land management, general technical report rm-247. Eds. W. W. Covington and L. F. Deb, 44–50. U.S. Forest Service, Rocky Mountain For. and Range Exper.i Stat., Fort Collins, CO.

Brennan, L. A. and W. M. Block. 1986. Line transect estimates of mountain quail density. J. Wild. Manage. 50:373–7.

Brennan, L. A., W. M. Block and R. J. Gutierrez. 1987. Habitat used by mountain quail in northern California. Condor 89:66–74.

Bristow, K. D. and R. A. Ockenfels. 2000. Effects of human activity and habitat conditions on Mearns' quail populations. Tech. Guidance Bull. 4. Arizona Game and Fish Department, Phoenix.

Bristow K. D.. and R. A. Ockenfels. 2002. Brood season habitat selection by Montezuma quail in southeastern Arizona. Proceed. Nat. Quail Symp. 5:111–6.

Bristow, K. D., and R. A. Ockenfels. 2004. Pairing season habitat selection by Montezuma quail in southeastern Arizona. J. Range. Manage.. 57:532–38.

Bristow, K. D., and R. A. Ockenfels. 2006. Fall and winter habitat use by scaled quail in southeastern Arizona. Journal of Rangeland Ecol. Manage. 59:308–13.

_____. 1989. Arizona game birds. Arizona Game and Fish Department and University of Arizona Press, Phoenix and Tucson, AZ.

Brown, D. E. and D. H. Ellis. 1977. Status summary and recovery plan for the masked bobwhite. U.S. Fish and Wildlife Service, Albuquerque, NM.

Brown, D. E., C. L. Cochran and T. E. Waddell. 1978. Using call-counts to predict hunting success for scaled quail. J. Wildl. Manage. 42:281–7.

Brown, D. E., J. C. Hagelin, M. Taylor and J. Galloway. 1998. Gambel's quail *(Callipepla gambelii)*. In The birds of North America, No. 321, eds. A. Poole, and F. Gills, 1–124. The Birds of North America, Inc., Philadelphia, PA.

Brown, H. 1900. Conditions governing bird life in Arizona. Auk 17:31–4.

_____. 1904. Masked bob-white *(Colinus ridgwayi)*. Auk 210–3.

Brown, R. L. 1978. An ecological study of Mearns' quail. Federal aid project W-78-R-22, final report. Arizona Game and Fish Department: Phoenix.

_____. 1979. Mearns' quail census method. Federal aid project W-78-R-15, final report. Arizona Game and Fish Department. Phoenix.

_____. 1982. Effects of livestock grazing on Mearns' quail in southeastern Arizona. J. Range. Manage.. 35:727–32.

Burger, L. W., Jr., M. R. Ryan, T. V Dailey and E. W. Kurzejeski. 1995. Reproductive strategies, success, and mating systems of northern bobwhite in Missouri. J. Wildl. Manage.. 59:417–26.

Cain, J. R., R. J. Lien and S. L. Beasom. 1987. Phytoestrogen effects on reproductive performance of scaled quail. J. Wildl. Manage.. 51:198–201.

California Partners in Flight. 2004. The coastal scrub and chaparral bird conservation plan: A strategy for protecting and managing coastal scrub and chaparral habitats and associated birds in California. PRBO Conservation Science, Stinson Beach, CA.

Calkins, J. D., J. C. Hagelin and D. F. Lott. 1999. California quail *(Callipepla californica)* In The birds of North America online, ed., A. Poole. http://bna.birds.cornell.edu/bna/species/473doi:10.2173/bna/473.

Camou-Luders, G., W. P. Kuvlesky, Jr. and F. S. Guthery. 1998. Rainfall and masked bobwhites in Sonora, Mexico, RMRS-P-5, 253-260. U. S. Forest Service: Fort Collins, CO.

Campbell, H. and B. K. Harris. 1965. Mass population dispersal and long-distance movements: Scaled quail. J. Wildl. Manage.. 29:801–5.

Campbell, H., D. K. Martin, P. W. Ferkovich and B. K. Harris. 1973. Effects of hunting and some other environmental factors on scaled quail in New Mexico. Wildl. Mono. 34:1–49.

Cottam, C. and P. Knappen. 1939. Foods of some uncommon North American birds. Auk 56:138–69.

Coues, E. 1866. List of birds of Fort Whipple, Arizona. Proceed. Nat. Acad. Sci. 18:71.
Crawford, J. A. 1986a. Annual variation in the hatching chronology of California quail at the E. E. Wilson Wildlife Area, Oregon. Murrelet 67:87–9.

Crawford, J. A. 1986b. Differential prevalence of avian pox in adult and immature California quail. J. Wild. Dis. 22:564–6.

Crawford, J. A. 1993. California quail in western Oregon: A review. In Quail III: Third National Quail Symposium, eds. K. E. Church, and T. V. Daily, 148–54. Kansas Wildlife and Parks. Pratt.

Crawford, J. A. 2000. Historic distribution of mountain quail in the Pacific Northwest. In Quail IV: National Quail Symposium, eds, L. A. Brennan, W. E. Palmer, L. W. Burger, Jr., and T. L. Pruden, 194–7. Tall Timbers Research Station, Tallahassee, FL.

Crawford, J. A. and R. M. Oats. 1986. Sex and age ratios of shot and trapped California quail. Wild. Soc. Bull.. 14:380–2.

Davis, C. A., R. C. Barkley and W. C. Haussamen. 1975. Scaled quail foods in southeastern New Mexico. J. Wildl. Manage.. 39:496–502.

Delehanty, D. J. 1995. Incubation and brood rearing by a wild male mountain quail. Western Birds 26:46–48.
_____. 1997. Mountain quail reproduction and restoration in the Great Basin. PhD. dissertation, Univ. Nevada, Reno.

Dobrott, S. J. 1992. Annual biological report. U.S. Fish and Wildlife Service, Buenos Aires National Wildlife Refuge, AZ.

Emlen, J. T. 1939. Seasonal movements of a low-density valley quail population. J. Wildl. Manage.. 3:118–30.

Emlen, J. T. and B. Glading. 1945. Increasing valley quail in California. California Agric. Exper. Sta. Bull. 695. 56pp.

Figge, H. 1946. Scaled quail management in Colorado. Proceed. West. Assoc. State Game and Fish Commiss. 26:161.

Fitzhugh, L. 1983. How to increase California quail populations. Leaflet 21325. Univ. California, Div. Agric. Sci. Coop. Ext. Unit, Davis.

Francis, W. J. 1970. The influence of weather on population fluctuations in California quail. J. Wildl. Manage.. 34:249–66.

Gallizioli, S. 1965. Quail research in Arizona: Federal aid project W-78-R. Arizona Game and Fish Department, Phoenix.

Gallizioli, S. and E. L. Webb. 1961. The influence of hunting upon quail populations: Federal aid project W-78-R. Arizona Game and Fish Department, Phoenix, Garcia-Solorzano, D., R. W. DeYoung, F. Hernandez, W. P. Kuvlesky, Jr., L. A. Brennan, S. A. Gall, F. S. Guthery and R. A. Van Den Bussche. 2006. Conservation genetics and analysis of population restoration efforts for the endangered masked bobwhite *(Colinus virginianus ridgwayi)*. Fourth No. Amer. Ornith. Con. Veracruz, Mexico. Genelly, R. E. 1955. Annual cycle in a population of California quail. Condor 57:263–5.

Glading B. 1938. Studies on the nesting cycle of the California quail in 1937. California Fish and Game Department 24:318–40.

_____. 1941. Valley quail census methods and populations at the San Joaquin Experimental Range. California Fish and Game Department 27:33–8.

Glading, B., D. M. Selleck and F. T. Ross. 1945. Valley quail under private management at the Dune Lakes Club. California Fish and Game Department 31:166–83.

Goodwin, J. G. 1982. Habitat needs of masked bobwhite in Arizona. Univ. Arizona, Tucson.

Goodwin, J. G., Jr. and C. R. Hungerford. 1977. Habitat use by native Gambel's and scaled quail and released masked bobwhite quail in southern Arizona. Research paper RM-197. U.S. Forest Service, Fort Collins, CO.

Gorsuch, D. M. 1934. Life history of the Gambel's quail in Arizona. Univ. Arizona Bull. 2:1–89.

Greenwalt, L. A. 1955. Mobility of Gambel's quail *(Lophortyx gambelii gambelii)* in a desert grassland-oak woodland area in southeastern Arizona. Thesis. Univ. Arizona, Tucson.

Grenfell, W. E., B. M. Browningand W. E. Stienecker. 1980. Food habits of California upland game birds. Admin. report 80-1. California Department of Fish and Game, Sacramento.

Grinnell, G. B. 1884. A quail new to the United States fauna. Forest and Stream 12:243.

Grinnell, J., H. C. Bryant and T. I. Storer. 1918. The game birds of California. Univ. California Press, Berkeley. Gutierrez, R. J. 1980. Comparative ecology of the mountain and California quail in Carmel Valley, California. Living Bird 18:71–93

Gutierrez, R. J. and D. J. Delehanty. 1999. Mountain quail *(Oreortyx pictus)*. In The birds of North America, No. 457, eds., A. Poole, and F. Gil, 1–28. The Birds of North America, Inc. Philadelphia, PA.

Gullion, G. W. 1956. Evidence of double brooding in Gambel's quail. Condor 58:232–4.

_____. 1960. The ecology of Gambel's quail in Nevada and the arid Southwest. Ecology 41:518–36.

_____. 1962. Organization and movements of coveys of a Gambel's quail population. Condor 64:402–15.

Gullion, G. W.,and A. M. Gullion. 1964. Water economy of Gambel's quail. Condor 66:32–40.

Guthery, F. S. 2000. On bobwhites. Texas A&M Univ. Press. College Station.
Guthery, F. S., C. L. Land and B. W. Hall. 2001. Heat loads on reproducing bobwhites in the semiarid subtropics. J. Wildl. Manage 65:111–7.

Guthery, F. S., N. E. Koerth and D. S. Smith. 1988. Reproduction of northern bobwhites in semiarid environments. J. Wildl. Manage.. 52:144–9.

Guthery, F. S., N. M. King, K. R. Nolte, W. P. Kuvlesky, Jr., S. DeStefano, S. A. Gall and N. J. Silvy. 2001. Comparative habitat ecology of masked bobwhites, scaled and Gambel's quail in southern Arizona. J. Wildl. Manage.. 65:850–60.

Heekin, P. E. 1993. Radio-telemetry reveals secrets of mountain quail in Idaho. Quail Unlimited Mag. 12:8–11.

Heekin, P. E., C. A. Vogel and K. P. Reese. 1994. Uncovering the elusive habits of mountain quail in Idaho. Quail Unlimited Mag. 13:14–16.

Heffelfinger, J. R. and R. J. Olding. 2000. Montezuma quail management in Arizona. Proceed. National Quail Symp. 4:183–90.

Heffelfinger, J. R., F. S. Guthery, R. J. Olding, C. L. Cochran, Jr. and C. M. McMullen. 1999. Influence of precipitation timing and summer temperatures on reproduction of Gambel's quail. J. Wildl. Manage.. 63:154–61.

Hensley, M. M. 1954. Ecological relations of the breeding bird population of the desert biome in Arizona. Ecol. Mono. 24:185–207.

_____. 1959. Notes on the nesting of selected species of birds of the Sonoran Desert. Wilson Bull. 71:86–92.

Hernandez, F., W. P. Kuvlesky, Jr., R. W. DeYoung, L. A. Brennan and S. A. Gall. 2006. Recovery of a rare species: Case study of the masked bobwhite. J. Wildl. Manage.. 70:617–31.

Hoffman, D. M. 1965. Scaled quail in Colorado. Tech. report No. 18. Colorado Game, Fish and Parks, Denver,.

Hungerford, C. R. 1960. The factors affecting the breeding of Gambel's quail *(Lophortix gambelii gambelii)* in Arizona. Dissertation, Univ. Arizona, Tucson.

_____. 1962. Adaptations shown in selection of food by Gambel's quail. Condor 64:213–19.

_____. 1964. Vitamin A and productivity in Gambel's quail. J. Wildl. Manage.. 28:141. Johnsgard, P. A. 1973. Grouse and quails of North America. Univ. Nebraska Press: Lincoln. Johnson, N. K. 1972. Origin and differentiation of the avifauna of the Channel Islands, California. Condor 74:295–315.

Kilbride, K. M. 1991. Applications of radiotelemetry to studies of California quail in western Oregon. M.S. thesis, Oregon St. Univ., Corvallis.

Kilbride, K. M. J. A. Crawford, K. L. Blakely and B. A. Williams. 1992. Habitat use by breeding female California quail in western Oregon. J. Wildl. Manage. 56:85–90.

Klimstra, W. D. and J. L. Roseberry. 1975. Nesting ecology of the bobwhite in southern Illinois. Wild. Mono. 41:1–37.

Latta, M. J., C. J. Beardmore and T. E. Corman. 1999. Arizona Partners in Flight birds conservation plan. Version 1.0. Nongame and Endangered Wildlife Program Tech. report 142. Arizona Game and Fish Department, Phoenix.

Lawson, L. L. 1951. Masked bobwhite and Benson quail trapping in Sonora, Mexico, Federal Aid Project W-40-R-2, Work Plan 2, Job 2, Completion Report. Arizona Game and Fish Department, Phoenix.

Leach, H. R. and W. H. Frazier. 1953. A study of the possible extent of predation on heavy concentrations of valley quail with special reference to the bobcat. California Fish and Game. 39:527–38.

Lehmann, V. W. 1946. Bobwhite quail reproduction in southwestern Texas. J. Wildl. Manage.. 10:124–36.

Leopold, A. S. 1977. The California quail. Univ. California Press, Berkeley.
Leopold, A. S. and R. A. McCabe. 1957. Natural history of the Montezuma quail in Mexico. Condor 59:3–26.

Levy, S. H. and J. J. Levy. 1984. Report of a brief reconnaissance of the Buenos Aires Ranch during August 1982 and 1983 in search of the masked bobwhite. U.S. Fish and Wildlife Service, Albuquerque, NM.

Ligon, J. S. 1952. The vanishing masked bobwhite. Condor 54: 48–50.
MacGregor, W. G., Jr. 1953. An evaluation of California quail management. Proceed. Annual Conf. Western Assoc. of State Game and Fish Commiss. 33:157–60.

MacGregor, W. G. and M. Inlay. 1951. Observations on failure of Gambel's quail to breed. California Fish and Game 37:218–9.

McMillan. I. I. 1964. Annual population changes in California quail. J. Wildl. Manage.. 28:702–11.

Medina, A. L. 1988. Diets of scaled quail in southern Arizona. J. Wildl. Manage.. 52:753–7.

_____. 2003. Gambel and scaled quail diets on the Santa Rita Experimental Range. In Santa Rita Experimental Range: 100 years (1903 to 2003) of accomplishments and contributions: Proceed. RMRS-P-30.2003, tech. coord 3: M. P. McClaran, Ffolliott, P. F., and Edminster, C. B., tech. cords, 133–40.. U.S. Department of Agriculture, Forest Service: Ogden, UT.

Miller, E. V. 1950. The life history and management of mountain quail in California. project W-19-R, final report. California Department of Fish and Game. Sacramento, CA.

Nelson, A.L. and A.C. Martin. 1953. Gamebird weights. J. Wildl. Manage. 17: 36-42.

Newman, T. 1978. Food habits of young-of-the-year California quail on California annual grass rangeland. Thesis. California St. Univ., Fresno.

Oates, R. M. and J. A. Crawford. 1983. Effects of habitat manipulation on California quail in western Oregon. J. Wildl. Manage.. 47:229–34.

Ough, W. D. and J. C. deVos, Jr. 1984. Masked bobwhite investigations on the Buenos Aires Ranch in 1982. U.S. Fish and Wildlife Service, Albuquerque, NM.

Pope, M. D. 2002. The ecology of mountain quail in Oregon. PhD. Dissertation, Oregon St. Univ., Corvallis.

Pope, M. D. and J. A. Crawford. 2001. Male incubation and biparental care in mountain quail. Condor 103:865–870.

_____. 2004. Survival rates of translocated and native mountain quail in Oregon. West. Great Basin Naturalist. 64:331–7.

Pope, M. D., M. Hanson and J. A. Crawford. 2004. Habitat associations of translocated and native mountain quail in Oregon. Northwest Sci. 78:242–8.

Pope, M. D., N. Richardson and J. A. Crawford. 2002. Fall and winter diets of mountain quail in southwestern Oregon. Northwest Sci. 76:261–5

Raitt, R. J. and R. E. Genelly. 1964. Dynamics of a population of California quail. J. Wildl. Manage.. 28:127–41.

Raitt, R. J. and R. D. Ohmart. 1966. Annual cycle of reproduction and molt in Gambel's quail of the Rio Grande Valley, southern New Mexico. Condor. 68:541–61.

Rollins, D. 1981. Diets of sympatric bobwhite and scaled quail in Oklahoma. Proceed. Ann. Conf. Southeast. Assoc. Fish and Wildl. Agencies 35:239–49.

_____ 2000. Status, ecology and management of scaled quail in west Texas. Quail IV: Proceed. Fourth National Quail Symp. 4:165–72.

Roseberry, J. L., and W. D. Klimstra. 1984. Population ecology of the bobwhite. So. Illinois Univ. Carbondale.

Rosene, W. 1969. The bobwhite quail—its life and management. Rutgers Univ., New Brunswick, NJ.

Saiwana, L., J. L. Holochek, A. Tembo, R. Valdez and M. Cardenas. 1998. Scaled quail use of different seral stages in the Chihuahuan Desert. J. Wildl. Manage.. 62:550–6.

Savage, A. E. 1974. Productivity and movement of California valley quail in northeast California. Trans. West. Sect. of The Wildlife Society Conf.

Schemnitz, S. D. 1961. Ecology of the scaled quail in the Oklahoma panhandle. Wild. Mono. 8:1–47.

_____.1993. Scaled quail habitats revisited In Oklahoma panhandle. Proceed. National Symp. on Quail 3:143–7.

_____. 1994. Scaled quail *(Callipepla squamata)*. In The Birds of North America, No. 106. eds., A. Poole, and F. Gills, 1–16. The Birds of North America, Inc.; Philadelphia, PA.

Schemnitz, S. D., J. L. Dye and M. Cardenas. 1998. Fall and winter foods of scaled and Gambel's quail in southwestern New Mexico. Agric. ext. bull. no. 777. New Mexico St. Univ., Las Cruces.

Senteney, P. E. 1957. Factors affecting the nesting of Gambel's quail in southern Arizona. Thesis. Univ. Arizona, Tucson, AZ.

Sharp, G. T., P. E. Lederle, C. L. Sowell and M. K. Cox. 1999. Survival, movements, and nesting activity of Gambel's quail at Yucca Mountain, Nevada: Contractor report B00000000-01717-5705-00071 Rev 00, U.S. Department of Energy, Civilian Radioactive Waste Management, System Management and Operation, Las Vegas, NV.

Siegel, R. B. and D. F. DeSante. 1999.The draft avian conservation plan for the Sierra Nevada bioregion: Conservation priorities and strategies for safeguarding Sierra bird populations, version 1.0. Institute for Bird Populations: Point Reyes Station, CA.

Simms, K. M. 1989. Home range, habitat use, and movements of reintroduced masked bobwhite. Thesis, Univ. Arizona, Tucson.

Smith, R. H. and S. Gallizioli. 1963. Gambel's quail population trend techniques: Federal aid project W-78-R. Arizona Game and Fish Department, Phoenix.

Sowls, L. K. 1960. Results of a banding study of Gambel's quail in southern Arizona. J. Wildl. Manage.. 24:185–90.

Stinnett, D. P. and D. A. Klebenow. 1986. Habitat use of irrigated lands by California quail in Nevada. J. Wildl. Manage.. 50:368–73.

Stormer, F. A. 1984. Night-roosting habitat of scaled quail. J. Wildl. Manage.. 48:191–7.

Stromberg, M. R. 1990. Habitat, movements, and roost characteristics of Montezuma quail in southeastern Arizona. Condor 92:229–36.

_____. 2000. Montezuma quail *(Cyrtonyx montezumae)*. In The Birds of North America, no. 524, eds. A. Poole, and F. Gills, 1–20. The Birds of North America, Inc. Philadelphia, PA.

Subsecretaria Forestal y de la Fauna, Direccion General de la Fauna Silvestre. 1982. Especies de fauna en peligro de extinction en Mexico. Primera reunion para la revision de los apendices I, II y III de la Convencion de las Especies amenazadas de flora y fauna silvestre. Instituto Mexicano del Comercio Exterior. Mexico. D. F.

Sumner, E. L., Jr. 1935. A life history study of the California quail, with recommendations for its conservation and management. California Fish and Game. 21:167–253, 275–342.

Swank, W. G. and S. Gallizioli. 1954. The influence of hunting and rainfall on Gambel's quail populations. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 19:283–96.

Tomlinson, R. E. 1972a. Review of literature on the endangered masked bobwhite. U.S. Fish and Wildlife Research Public. 108:1–28.

_____. 1972b. Current status of the endangered masked bobwhite quail. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 37:294–311.

_____. 1975. Weights and wing lengths of wild Sonoran masked bobwhite during fall and winter. Wilson Bull. 87:180–6.

_____. 1984. Habitat needs of the masked bobwhite in Mexico. In Masked bobwhite biology and conservation: Proceedings of a Symposium, eds. M. R. Stromberg, T. B. Johnson, and S. W. Hoffman, 12–4. Arizona Game and Fish Department, Tucson.

U.S. Fish and Wildlife Service. 1995. Masked bobwhite *(Colinus virginianus ridgwayi)* recovery plan. U.S. Fish and Wildlife Service, Albuquerque, NM.

Van Rosem, A. J. 1945. A distributional survey of the birds of Sonora, Mexico. Occas. Papers Mus. Zool. Louisiana St. Univ. 21:379.

Wallmo, O. C. 1954. Nesting of Mearns' quail in southeastern Arizona. Condor 56:125–8.

_____. 1956a. Determination of sex and age of scaled quail. J. Wildl. Manage.. 20:154–8.

_____. 1956b. Ecology of scaled quail in west Texas. Texas Game and Fish Commission, Austin.

Montezuma Quail desert habitat/Larry Kruckenberg

Wallmo, O. C. and P. B. Uzzell. 1958. Ecological and social problems in quail management in west Texas. Trans. No. Amer. Wildl. and Natur. Resour. Con. 23:320–7.

Wilson, M. and J. A. Crawford. 1987. Habitat selection of Texas bobwhites and chestnut-bellied scaled quail in south Texas. J. Wildl. Manage.. 51:575–82.

Yeager, W. M. 1966. Mearns' quail management information: Federal aid project W-53-R-16. Arizona Game and Fish Department. Phoenix.

Zornes, M. 2005. Project performance report, Federal aid project W-53-M-55. Arizona Game and Fish Department. Phoenix.

Appendix A:

Plants, animals and invertebrates named in the text

Plants

fir, balsam	*Abies balsamea*
fir, grand	*Abies grandis*
fir, subalpine	*Abies lasiocarpa*
acacia, whiteball	*Acacia angustissima*
acacia, catclaw	*Acacia greggii*
acacia	*Acacia spp.*
ragweeds	*Ambrosia spp*
serviceberry	*Amelanchier alnifolia*
fiddleneck	*Amsinckia sp.*
manzanita	*Arctostaphylos spp.*
sagebrush	*Artemesia*
smallflowered milkvetch	*Astragalus nuttalianus*
saltbushes	*Atriplex spp.*
Fremont barberry	*Berberis fremontii*
bromegrass	*Bromus spp.*
Cacti	*Cactacea spp.*
buckbrush	*Ceanothus cuneatus*
ceanothus	*Ceanothus spp.*
spiny hackberry	*Celtis ehrenbergiana*
desert or spiny hackberry	*Celtis pallida,*
palo verde	*Cercidium spp*
partridge pea	*Chamaecrista nictitans*
dayflower	*Commelina elegans*
hawthorn	*Crataegus sp.*
yellow nutsedge	*Cyperus esculentes*
tansymustards	*Descurainia spp.*
Lehmann's lovegrass	*Eragrostis lehmanniana*
California buckwheat	*Eriogonum fasciculatum*
filaree	*Erodium cicutarium*
leafy spurge	*euphorbia eusala*
fescue	*Festuca spp.*
silk tassel	*Garrya spp.*
snakeweed	*Gutierrezia sarothrae*
toyon	*Heteromeles arbutifolia*

Appendix A continued: Plants

morning glory	*Ipomoea eriocarpa*
piñon-juniper	*Juniperus osteosperma and Juniperus scopulorum*
western larch	*Larix lyallii*
creosote bush	*Larrea tridentata*
ryegrass	*Lolium spp.*
lotus	*Lotus*
foothill deervetch	*Lotus humistratus*
deervetches	*Lotus spp.*
lupine	*Lupinus sparsiflorus*
desert thorn	*Lycium spp.*
bur clover	*Medicago hispida*
prickly pear	*Opuntia spp.*
Cholla Cactus	*Opuntia spp.*
Gray' woodsorrel	*Oxalis grayi*
panic grasses	*Panicum spp.*
buffelgrass	*Pennisetum ciliare*
ground cherry	*Physalis spp.*
Engleman spruce	*Picea engelmannii*
spruce, Sitka	*Picea sitchensis*
lodgepole	*Pinus contorta*
Lodgepole pine	*Pinus contorta*
ponderosa pine	*Pinus ponderosa*
pine	*Pinus spp.*
aspen	*Populus spp.*
black cottonwood	*Populus trichocarpa*
western honey mesquite	*Prosopis juliflora*
screwbean mesquite	*Prosopis pubescens*
mesquite	*Prosopis spp.*
velvet mesquite	*Prosopis velutina*
chokecherry	*Prunus virginiana*
Douglas fir	*Pseudotsuga menziesii*
Emory oak,	*Q. emoryi)*
Arizona white oak	*Quercus arizonica*
shrub live oak	*Quercus turbinella*

Appendix A continued: Plants

redberry	*Rhamnus crocea*
laurel sumac	*Rhus laurina*
little-leaf sumac	*Rhus microcarpa*
squaw bush	*Rhus trilobata*
Russian thistle	*Salsola kali*
redwood	*Sequoia sempervirens*
bristlegrasses	*Setaria spp.*
jojoba	*Simmondsia chinensis*
needle-grass	*Stipa spp.*
snowberry	*Symphoricarpos spp.*
saltcedar	*Tamarix spp*
western red cedar	*Thuja plicata*
poison oak	*Toxicodendron radicans*
clover	*Trifolium*
western hemlock	*Tsuga heteropylla*
yucca	*Yucca sp.*

Animals

Cooper's hawk	*Accipiter cooperii*
northern goshawks	*Accipiter gentilis,*
sharp-shinned hawk	*Accipiter striatus*
scrub jay	*Aphelocoma californica*
great-horned owl	*Bubo virginianus*
red-tailed hawk	*Buteo jamaicensis*
California quail	*Callipepla californica*
Gambel's quail	*Callipepla gambelii*
scaled quail	*Callipepla squamata*
coyote	*Canis latrans*
dogs	*Canis lupus familiarus*
northern harrier	*Circus cyaneus*
northern bobwhite	*Colinus virginianus*
masked bobwhite	*Colinus virginianus ridgwayi*
snake	*Colubridae and Viperidae*
Montezuma quail,	*Cyrtonyx montezumae*
opossums	*Didelphus virginiana*
prairie falcon	*Falco mexicanus*
kestrel	*Falco sparverius*

Appendix A continued: Animals

cat	*Felix domesticus*
roadrunner	*Geococcyx californianus*
Gila monster	*Heloderma suspectum*
bobcat	*Lynx rufus*
skunk	*Mephitis spp., Conepatus spp., and Spilogale putorius*
long-tailed weasel	*Mustela frenata*
coatis	*Nassua narica*
wood rat'	*Neotoma's spp*
mountain quail	*Oreortyx pictus*
Harris hawk	*Parabuteo unicinctus*
javelina	*Pecari tajacu*
raccoons	*Procyon lotor*
bullfrog	*Rana catesbeiana*
cotton rat	*Sigmodon spp.*
Beechey ground squirrel	*Spermophilus beecheyi.*
ground squirrel	*Spermophilus spp*
gray fox	*Urocyon cinereoargenteus*

Invertebrates

beetles	Coleoptera
ants	Formicidae
true bugs	Hemiptera
grasshoppers	Locustidae
termites	Isoptera
butterflies	Lepidoptera
earwigs	Dermaptera
spiders	Araneae

National Fish and Wildlife Foundation

ASSOCIATION of FISH & WILDLIFE AGENCIES

WILDLIFE MANAGEMENT INSTITUTE · WASHINGTON, D.C. ·