Sierra Nevada Individual Species
Vulnerability Assessment Briefing: Mountain Quail

Oreortyx pictus

Background and Key Terminology

This document summarizes the primary factors that influence the vulnerability of a focal resource to climate change over the next century. In this context, vulnerability is a function of the sensitivity of the resource to climate change, its anticipated exposure to those changes, and its capacity to adapt to changes. Specifically, sensitivity is defined as a measure of whether and how a resource is likely to be affected by a given change in climate, or factors driven by climate; exposure is defined as the degree of change in climate or climate-driven factors a resource is likely to experience; and adaptive capacity is defined as the ability of a resource to accommodate or cope with climate change impacts with minimal disruption (Glick et al. 2011). The purpose of this assessment is to inform forest planning by government, non-profit, and private sector partners in the Sierra Nevada region as they work to integrate climate change into their planning documents.

Executive Summary

The overall vulnerability of the mountain quail is ranked moderate, due to moderate sensitivity to climate and non-climate stressors, moderate adaptive capacity, and moderate exposure.

Mountain quail are directly and indirectly sensitive to climate-driven changes such as:
- reduced water availability (precipitation volume and timing),
- climatic water deficit, and
- altered fire regimes.

Mountain quail inhabit dry areas and may be sensitive to further reductions of available water. Increased frequency and severity of fire may reduce resprouting success of chaparral species, resulting in alterations in vegetative cover and conversion to unsuitable habitat.

Mountain quail are sensitive to non-climate stressors including:
- water diversion,
- habitat conversion (e.g. logging and residential development), and
- invasive annual grasses.

These non-climate stressors can limit water available to mountain quail, and reduce the availability and connectivity of chaparral habitat, compounding the effects of climate-driven changes to the system. Adaptive capacity of the species may be facilitated by its flexible biotic and abiotic dietary and habitat requirements.

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Sensitivity & Exposure

Sensitivity to climate and climate-driven changes

Distribution and abundance of mountain quail in the Sierra Nevada may become a concern if surface and preformed water availability becomes more limiting as a result of altered snowpack, and increased climatic water deficit. Mountain quail occupy arid regions from Baja California, Mexico, to the Coast Range of central California (AOU 1983 cited in Brennan et al. 1987), where summers often experience drought conditions. Under dry conditions, the mountain quail requires free water and drinks frequently (Rahm 1938, Miller and Thompson 1948 cited in Gutierrez and Delehanty 1999). However, when moist vegetation is available, the mountain quail does not require free water (Gutierrez 1980 cited in Winter 2002). Mountain quail, particularly juveniles, may require a significant intake of preformed water to regulate body temperatures during hot months (Dawson and Bartholomew 1968 cited in Delehanty et al. 2004), through consumption of vegetation (Campbell 1960, Leopold 1977, Prasad and Guthrey 1986, Guthrey 1999, and Stromberg 2000 cited in Delehanty et al. 2004), insects (Dawson and Bartholomew 1968, Leopold 1977 cited in Delehanty et al. 2004), and tubers (Stromberg 2000 cited in Delehanty et al. 2004). Increased climatic water deficit, resulting from changes in the timing and volume of snowpack combined with warming temperatures, may alter vegetation type and timing, reducing the availability of preformed water.

The effects of wildfire on mountain quail are not well understood. In California, mountain quail occupy montane chaparral, shrublands, early- and mid-seral conifer forests and habitats (Brennan and Block 1986; Brennan et al. 1987; Roberts et al. 2011) with high tree crown coverage and abundant shrubs, and avoid areas of open ground, such as annual grasslands (Gutierrez 1977 cited in Vogel and Reese 1995; Brennan et al. 1987). Fire may benefit mountain quail by returning plant communities to early-seral stages, and producing high quality habitat. However, increased severity and frequency of fires that reduce resprouting success of chaparral shrubs (Rundel et al. 1987, Moreno and Oechel 1991, and Borchert and Odion 1995, cited in Keeley et al. 2005) and result in the conversion of native early-seral shrub communities to annual grassland may reduce mountain quail habitat.

Future climate exposure

Important climate and climate-driven factors to consider for the mountain quail include changes that impact water availability and vegetation type and timing, including precipitation, snowpack, climatic water deficit, and wildfire. The forecast for chaparral distribution in response to climate change is not uniform throughout California, and for mountain quail it is unclear whether projected loss of habitat in the southern portion of its range will be offset by gains further north. In northwestern California, the predominant effects of climate change by 2070 are predicted to include increases in the distribution of chaparral, oak and pine, and a loss of conifer dominated vegetation, while in the southwestern and central-western California, chaparral is predicted to decrease (PRBO Conservation Science 2011).

Precipitation: Precipitation has increased slightly (~2%) in the Sierra Nevada over the past 30 years compared with a mid-twentieth century baseline (1951-1980) (Flint et al. 2013). Projections for future precipitation in the Sierra Nevada vary among models; in general, annual precipitation is projected to exhibit only modest changes by the end of the century (Hayhoe et al. 2004; Dettinger 2005; Maurer 2007; Cayan et al. 2008), with decreases in summer and fall (Geos Institute 2013). Frequency of extreme precipitation, however, is expected to increase in the Sierra Nevada between 18-55% by the end of the century (Das et al. 2011).

Snow volume and timing: Despite modest projected changes in overall precipitation, models of the Sierra Nevada region largely project decreasing snowpack and earlier timing of runoff (Miller et al. 2003; Dettinger et al. 2004b; Hayhoe et al. 2004; Knowles and Cayan 2004; Maurer 2007; Maurer et al. 2007; Young et al. 2009), as a consequence of early snowmelt events and a greater percentage of precipitation falling as rain rather than snow (Dettinger et al. 2004a, 2004 b; Young et al. 2009; Null et al. 2010). Annual snowpack in the Sierra Nevada is projected to decrease between 64-87% by late century (Thorne et al. 2012; Flint et al. 2013), with declines of 10-25% above 3750 m (12303 ft), and 70-90% below 2000 m (6562 ft) (Young et al. 2009). The greatest declines in snowpack are anticipated for the northern Sierra Nevada (Safford et al. 2012), with current pattern of snowpack retention in the higher-elevation southern Sierra Nevada basins expected to continue through the end of the century (Maurer 2007). The greatest losses in snowmelt volume are projected between 1750 m to 2750 m (5741 ft to 9022 ft) (Miller et al. 2003; Knowles and Cayan 2004; Maurer 2007; Young et al. 2009).

Snow provides an important contribution to spring and summer soil moisture in the western U.S. (Sheffield et al. 2004), and earlier snowmelt can lead to an earlier, longer dry season (Westerling et al. 2006). A shift from snowfall to rainfall is also expected to result in flashier runoff with higher flow magnitudes, and may result in less water stored within watersheds, decreasing meal annual flow (Null et al. 2010). Mean annual flow is projected to decrease most substantially in the northern bioregion (Null et al. 2010).

Climatic water deficit: Climatic water deficit, which combines the effects of temperature and rainfall to estimate site-specific soil moisture, is a function of actual evapotranspiration and potential evapotranspiration. Increases in potential evapotranspiration will likely be the dominant influence in future hydrologic cycles in the Sierra Nevada, decreasing runoff even under forecasts of increased precipitation, and driving increased climatic water deficits (Thorne et al. 2012). In the Sierra Nevada, climatic water deficit has increased slightly (~4%) in the past 30 years compared with the 1951-1980 baseline (Flint et al. 2013). Future downscaled water deficit modeling using the Basin Characterization Model predicts increased water deficits (i.e., decreased soil moisture) by up to 44%, with the greatest increases in the northern Sierra Nevada (Thorne et al. 2012; Flint et al. 2013; Geos Institute 2013).

Wildfire: Both the frequency and annual area burned by wildfires in the western U.S. have increased strongly over the last several decades (Westerling et al. 2006). Fire severity in the Sierra Nevada also rose from 17% to 34% high-severity (i.e. stand replacing) fire, especially in middle elevation conifer forests (Miller et al. 2009). In the Sierra Nevada, increases in large fire extent have been correlated with increasing temperatures and earlier snowmelt (Westerling and Bryant 2006), as well as current year drought combined with antecedent wet years (Taylor and Beaty 2005). Occurrence of large fire and total area burned in California are predicted to continue increasing over the next century, with total area burned increasing by up to 74% by 2085 (Westerling et al. 2011). The area burned by wildfire in the Sierra Nevada is projected to increase between 35-169% by the end of the century, varying by bioregion, with the greatest increases projected at mid-elevation sites along the west side of the range (Westerling et al. 2011; Geos Institute 2013).

More information on downscaled projected climate changes for the Sierra Nevada region is available in a separate report entitled *Future Climate, Wildfire, Hydrology, and Vegetation Projections for the Sierra Nevada, California: A climate change synthesis in support of the Vulnerability Assessment/Adaptation Strategy process* (Geos Institute 2013). Additional material on climate trends for the system may be found through the TACCIMO website (http://www.sgcp.ncsu.edu:8090/). Downscaled climate projections available through the Data Basin website (http://databasin.org/galleries/602b58f9bbd44dffb487a04a1c5c0f52).

Sensitivity to non-climate stressors

Non-climate stressors may exacerbate impacts of climate changes and perpetuate mountain quail declines in the Sierra Nevada and Great Basin region. Destruction of riparian shrub plants due to livestock grazing, dams, cheatgrass, weeds, and brush clearing are cited as reasons for the decline in these populations of mountain quail (Brennan 1994 cited in Winter 2002). Grazing may damage habitat, and development of private inholdings may fragment habitat and introduce domestic pet predators (Winter 2002). Type-conversion of shrublands to non-native grasslands is believed to be partially responsible for the decline of mountain quail populations in the intermountain west (Gutierrez and Delehanty 1999). Moreover, mountain quail are sensitive to reduction of surface water due to diversion for agriculture, mining, and urban use.

Adaptive Capacity

The capacity of mountain quail to accommodate changes in climate may be hindered by its small population size, but facilitated by its flexible biotic and abiotic dietary and habitat requirements (Vogel and Reese 1995; Gutierrez and Delehanty 1999). Mountain quail have a diet of vegetal and animal matter (Judd 1905 cited in Vogel and Reese 1995), consisting primarily of forbs. At the ecosystem level, mountain quail have the ability to inhabit different types of mixed shrub and early seral plant communities in the different segments of their range (Vogel and Reese 1995). Macrohabitats are generally used in proportion to the relative areas of available cover types (Brennan et al. 1987), suggesting a degree of plasticity that may accommodate future shifts in vegetation. However, mountain quail have a strong behavioral avoidance of open ground at the macrohabitat level (Gutierrez 1977 cited in Vogel and Reese 1995), and may not tolerate type conversion to grassland.

Mountain quail are considered among the more mobile of the order *Odontophoridae* (Gutierrez 1975; Gutierrez and Delehanty 1999) with individual movements up to 25 km in the non-breeding season (Delehanty et al. 2004), which may support potential future dispersal. Although non-migratory resident populations exist (Roberts et al. 2011), many populations engage in migrations seasonally, moving upslope to breed and downslope in fall to avoid deep snow (Brennan et al. 1987; Vogel and Reese 1995). Mountain quail may be benefited by reduced snowpack and a rising snow line, allowing mountain quail to colonize relatively northern mountains of the Sierras and Cascades. In contrast, mountain quail may be least able to adapt and persist in the southern portion of their range. Range limitations resulting from water dependence of breeding mountain quail may be influenced by the availability and location of water ‘guzzlers’, which experience heavy use once they are colonized by quail (Delehanty et al. 2004).

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