Species Status Assessment Report for the Gunnison Sage-Grouse (*Centrocercus minimus)*

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INTRODUCTION

The Gunnison sage-grouse (*Centrocercus minimus*; or GUSG) is a small bird in the grouse family that lives exclusively in the sagebrush steppe ecosystems of southwestern Colorado and southeastern Utah. GUSG is currently listed a threatened species under the Endangered Species Act.

This Species Status Assessment (SSA) report documents our species status assessment (SSA) analysis for GUSG, which is an in-depth, scientific review of the species' biology and threats, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain populations over time, or its viability. We define viability of the species to maintain populations in the wild over time with little management assistance. This SSA report will help support recovery planning for the species and we intend to update this SSA report as new information becomes available. This SSA report may also support other functions of our ecological services program, as needed. As such, the SSA report will be a living document, updated as needed to support conservation and provide the scientific foundation for any other decisions and documents needed under the Endangered Species Act, such as recovery plans, recovery implementation strategies (RISs), and 5-year reviews.

This version of the SSA report will provide the scientific information to help inform GUSG recovery planning. This SSA report does not result in any regulatory decision by the U.S. Fish and Wildlife Service (Service) under the Endangered Species Act. Instead, this SSA report provides a thorough eview of the best available scientific and commercial information regarding the biological status of GUSG. Recovery planning documents will be drafted and issued by the Service after reviewing this document and all relevant laws, regulations, and policies. The results of any regulatory processes will be announced in the *Federal Register*, with opportunities for public input, as appropriate. We expect to publish a notice of availability for the draft recovery plan before September 30, 2019.

For this SSA, we define viability as the ability of GUSG to sustain populations in the wild over time. Using the SSA framework, we considered what the species needs to maintain viability by characterizing the status of the species in terms of the three conservation biology principles of resiliency, redundancy, and representation, collectively known as the three Rs (Service 2016, entire; Smith *et al.* 2017, entire).

- **Resiliency** describes the ability of a species to withstand stochastic disturbance. Resiliency is positively related to population size and growth rate and may be influenced by connectivity among populations. Generally speaking, populations need abundant individuals within habitat patches of adequate area and quality to maintain survival and reproduction in spite of disturbance.

- **Redundancy** describes the ability of a species to withstand catastrophic events; it is about spreading the risk among multiple populations to minimize the potential loss of the species from catastrophic events. Redundancy is characterized by the presence of multiple, resilient populations distributed within the species' ecological settings and

across the species' range. It can be measured by population number, resiliency, spatial extent, and degree of connectivity. Our analysis explores the influence of the number, distribution, and connectivity of populations on the species' ability to withstand catastrophic events (e.g., rescue effect).

- **Representation** describes the ability of a species to adapt to changing environmental conditions over time. It is characterized by the breadth of genetic and environmental diversity within and among populations. Measures may include the number of varied niches occupied, the gene diversity, heterozygosity or alleles per locus. Our analysis explores the relationship between the species life history, the influence of environmental factors, and the species' ability to adapt to changing environmental conditions over time.

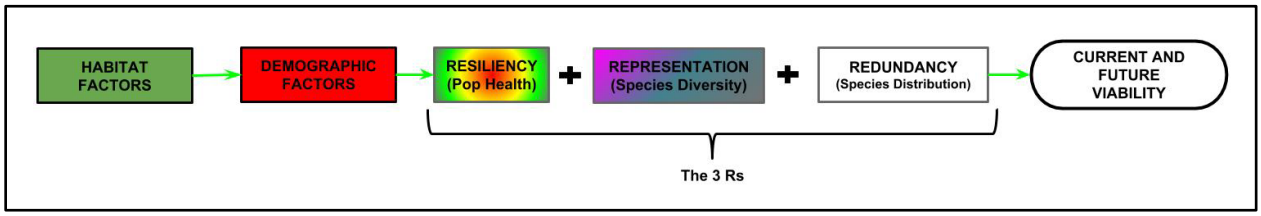


Figure 1. Core conceptual model of the SSA framework (Smith et al. 2018) used in this SSA report to evaluate the current and future viability of GUSG. Throughout the figures and tables in this SSA report, habitat factors are identified in green and demographic factors are in red.

Using the three Rs, we evaluated the current and future viability of GUSG based on the presence of multiple (redundancy), self-sustaining (resiliency) populations distributed across the range of the species (redundancy), and their contributions to adaptive capacity of the species in the face of changing environmental conditions (representation). The three Rs are our common terminology used throughout our analysis to discuss condition and risk to the species, and in turn viability. Our approach for assessing GUSG viability using the SSA framework (Smith *et al.* 2018, entire) involved three primary phases of analysis.

- In Phase 1, Species Needs, we described the species' ecological requirements for survival and reproduction at the individual, population, and species levels using the 3Rs (resiliency, redundancy, and representation).
- In Phase 2, Current Condition, we assessed the species' current condition in relation to the 3Rs and ongoing factors (stressors and beneficial factors) that influence the species' current condition.
- In Phase 3, Future Condition, we used the baseline conditions established in Phase 2 and the predictions for future stressors and beneficial factors to project potential future conditions of GUSG under plausible future scenarios.

The species' ecological needs (Phase 1) are summarized in Chapter 2, the current condition of the species and its habitat (Phase 2) is summarized in Chapter 3, and the species future condition and status (Phase 3) are summarized in Chapter 4. Throughout our analysis, we documented uncertainties and assumptions.

1.1.1 Information Compilation, Peer and Partner review

Partners and scientific experts, including experts from Colorado Parks and Wildlife (CPW), the Utah Department of Fish and Game, the Bureau of Land Management (BLM), the U.S. Forest Service (USFS), the Natural Resources Conservation Service (NRCS), National Park Service (NPS), private landowners, and counties within the range of GUSG provided data for our analysis.

We also collaborated with scientific experts on sage-grouse ecology and sagebrush habitat during three expert workshops (Expert Elicitation Meeting Notes, 2017, 2018a, 2018b). Scientific experts at these workshops included biologists from other Federal agencies, CPW, UDWR, and local governments. Experts from non-government organizations, academic institutions, and private research institutions also contributed to this assessment. We conducted expert elicitation workshops in November 2017, March 2018, and July 2018 to discuss research efforts, the factors influencing GUSG, and the current and future conditions of the species. We used the information from the expert workshops to help us define what GUSG populations need to be considered resilient (healthy). We then used the expert input to develop an analysis of population resiliency using available metrics for some of the demographic and habitat requirements.

Following peer and partner review of the SSA in November 2018, we made substantial changes to the SSA. Main topics of concern among most reviewers were (1) lack of GUSG specific literature citations and an over-reliance on GRSG data; (2) confusion over resiliency, redundancy, and representation; and (3) conclusive statements without supporting literature or acknowledgement of uncertainty. Below, we summarize the changes and the resulting modifications (4):

1. **GRSG as a surrogate for GUSG** - Although GUSG and GRSG are very similar, studies indicate that the two species may have different behaviors and habitat selection (Young 1994), differences which could influence management actions. Therefore, using research on GRSG to supplement or fill in gaps about GUSG is useful, but we have reviewed new and existing GUSG literature and updated information in the SSA accordingly.

2. **Resiliency, redundancy, and representation:** Our introduction clarifies these conservation biology principles, collectively known as the three Rs, and how we used them to summarize the current and future conditions for GUSG in our SSA analysis. Additionally, we modified the population and species-level needs (Chapter 2) to reflect that resiliency is a population-level need and that representation and redundancy are species-level needs. Further, in the current conditions (Chapter 3), we revisited the metrics and factors used to categorize population resiliency in the Conditions Category Table (Table 5) to better incorporate the available demographic and habitat data. We also added a "critical" category with corresponding thresholds. As a result, our evaluation of current population resiliency has changed slightly from the peer and partner reviewed draft and aligns more accurately with the current condition for each populations.

3. **Conclusive statements**: Throughout this SSA report, we have corrected any conclusive statements that did not have supporting literature, or accurately expressed our uncertainty and assumptions for conclusions where supporting citations are not available. Conclusive statements without citations may also signify the conclusions of our own, original analysis as part of our SSA.

4. **Resulting Modifications**: Following our clarifications of the three Rs and population analysis, we recognized that some of the habitat analyses included in the peer and partner reviewed SSA report were outdated or in need of further review. Habitat analyses included a calculation of the level of piñon-juniper/conifer encroachment, cheatgrass/invasive plants, human disturbance within occupied habitat, and an assessment of habitat fragmentation. Increased conifer establishment in sagebrush is a stressor that was better suited in our influences section (Chapter 3). Additionally, conifer cover and the amount of human disturbance we already accounted for in our habitat quantity estimate, which used sagebrush habitat types (SWReGAP) and clipped out human disturbance and conifer cover greater than 10 percent. Invasive plant species are a negative influence on the habitat quality of GUSG, and based on peer and partner comments and knowledge of the land, our analysis underestimated cheatgrass/invasive plants in GUSG range. A fourth analysis which quantified sagebrush habitat fragmentation in occupied and unoccupied GUSG range may be useful in determining where to maximize conservation efforts in recovery planning, but did not change our analysis of current conditions. If fragmentation and disruption of continuous sagebrush patches increases, there will be an associated loss of habitat and decrease in quality.

2 SPECIES ECOLOGY AND NEEDS

In this chapter, we summarize basic biological information about GUSG, including its habitats, taxonomy, morphological description, life stages, and reproductive and other important life history traits. This is not an exhaustive review of all information known about GUSG, but rather a focused summary of important ecological information needed to help inform our SSA analysis. We then identify the resource needs of individuals, populations, and the species as a whole. Resource needs are those habitat or other environmental factors that individual GUSG need to breed, feed, and shelter, used by an individual to complete each phase of the species life cycle. Population needs are the demographic factors, such as population size and growth rate, needed for populations to withstand stochastic events (resiliency). Finally, species needs are the number and distribution (redundancy) of resilient populations and the full breadth of their diversity (representation).

2.1 SPECIES DESCRIPTION

The Gunnison sage-grouse (*Centrocercus minimus*, hereafter GUSG), is the second largest grouse in North America. The Services' listing decision describes the species as occurring in seven small, localized populations in central and western Colorado and eastern Utah (50 FR

69191). GUSG were formerly native to southwest Colorado, northern New Mexico, southeastern Utah, and northeastern Arizona (Young *et al.* 2000, p. 446), but are now found exclusively in Colorado and Utah. Sage-grouse (*Centrocercus* spp.) and are closely associated with sagebrush (*Artemisia*) ecosystems in North America (Young *et al.* 2015, p. 1).

Genetically, the Dove Creek-Monticello subpopulations are similar to each other and distinct enough from the other populations to be considered a single population (Oyler-McCance *et al.* 2005, p. 634). However, due to very low high male counts (HMCs), the apparent lack of movement between the two units, different management actions between the states of Utah and Colorado we are treating them as individual populations for our SSA. Therefore, we refer to eight populations of GUSG for the remainder of this report.

Male GUSG are larger than females, weighing from 1.7–2.4 kg (3.7–5.3 lbs.) and females weigh 0.9–1.3 kg (2.0–2.9 lbs.) (Young *et al.* 2000, p. 447). GUSG are dark brown in color with black underparts, and coarsely barred brown-white or white-yellow tail feathers. During the non-breeding seasons, males and females appear similar except females are smaller with shorter feathers and the yellow-green eye comb is larger on males (Young *et al.* 2000, p. 448). Adult males are most conspicuous during the breeding season when they have developed long, thin, black, specialized ornamental contour feathers (filoplumes) on the back of the neck and rounded air sacs that are greenish-yellow within a white upper breast with scale-like feathers (Young *et al.* 2000, p. 448) (Figure 2). During the breeding season, males use the air sacs to create a popping sound nine times and strut on leks to attract females. Strutting is slower than other species of sage-grouse (Young 1994, p. 15). Juveniles resemble adults of their sex but may be distinguished for up to 17 months by two outermost primaries that are more pointed than adult primaries (Braun and Schroeder 2015, p. 183).

Figure 2 male GUSG in breeding plumage. Photo by Bob Gress.

GUSG eggs ranges from deep olive-buff and light olive buff color to greenish drab and greenish white with lighter shades of brown or olive green, and are marked with small spots of chocolate

brown and brownish olive ovate. Eggs average 54.5 mm in length and 38.0 mm in diameter (Young 1994, p. 37; Young *et al*. 2015, p. 12).

2.2 TAXONOMY

GUSG and greater sage-grouse (GRSG) (*C. urophasianus*) are birds in the Phasianidae family, which is a diverse taxonomic group including turkeys (*Meleagris* spp.), pheasants (*Phasianus* spp.), and partridges (*Perdix* spp.). Taxonomists previously considered GUSG and GRSG a single species, but GUSG are now considered a distinct species based on geographical isolation and morphological, genetic, and behavioral differences from GRSG (Young *et al.* 2000, 445; Banks *et al.* 2000, p. 850).

2.3 LIFE STAGES AND BASIC LIFE HISTORY

GUSG have six primary life stages, beginning with eggs and ending with breeding age adults at approximately 21 months of age (Figure 3). GUSG reach sexual maturity in one year and may live up to six years (Connelly *et al.* 2004, pp. 3-12), however survivorship varies by year, sex, and age (Davis *et al.* 2015, pp. 186-192) which we discuss more under the Population Needs section. Eggs hatch after 27 to 29 day incubation period. Males begin to appear and strut on leks beginning in March with peak breeding occurring in April, with exact onsets and peak lek attendance varying 1 to 3 weeks depending on winter severity. Females initiate nests in April, May, and sometimes June if their first nest is lost to depredation early enough in the incubation period, although this appears uncommon in the Gunnison Basin population (Young 1994, pp. 37-44). Nest initiation depends on snow depth and the age of the female.

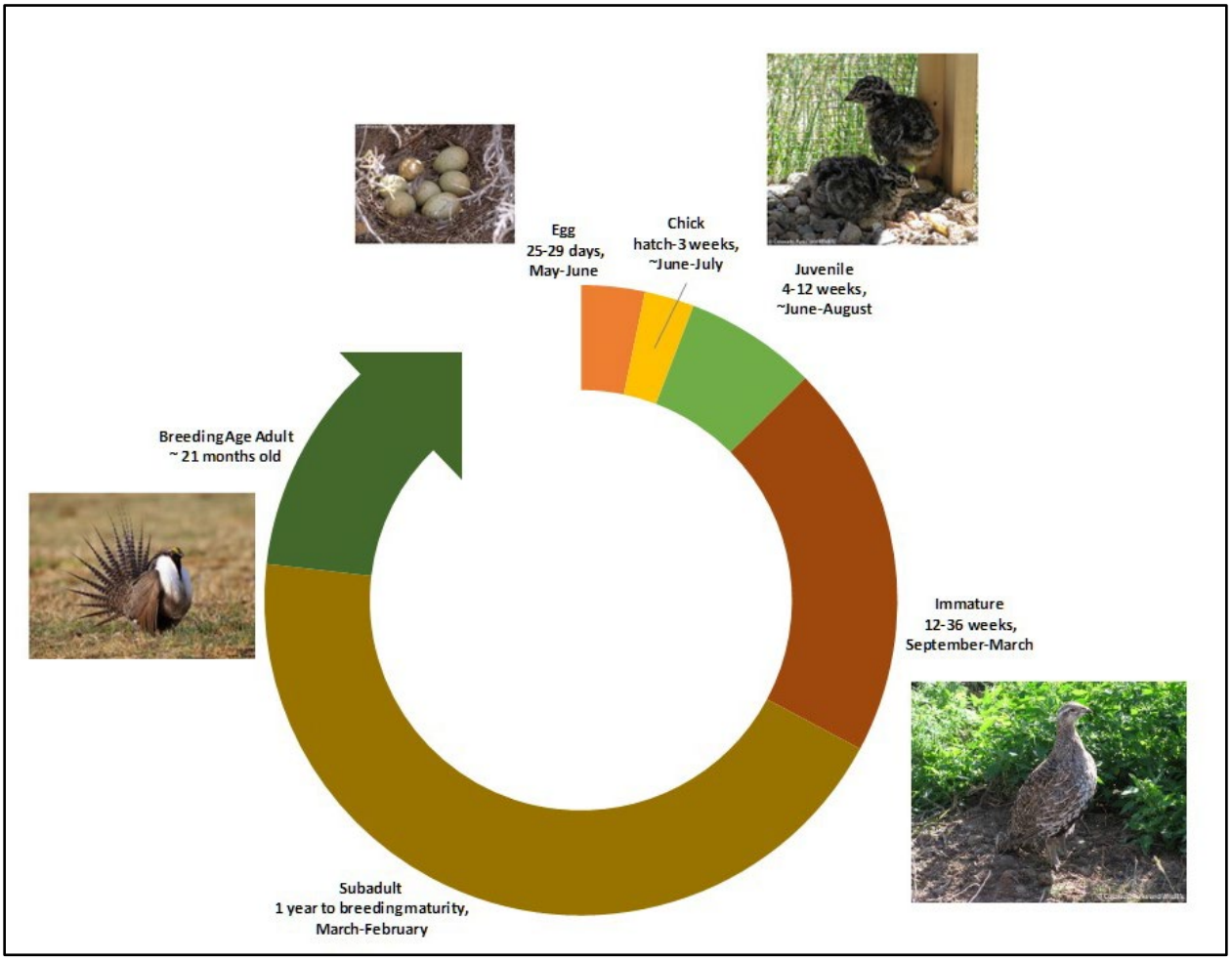


Figure 3. Life cycle diagram for GUSG illustrating the six life stages. Photos used with permission from CPW.

GUSG are a lek breeding species, with males breeding with multiple females during the same season. Breeding occurs on leks, or distinct areas where males strut, or display, to attract females. Both male and female sage-grouse exhibit breeding and nesting site fidelity (Connelly *et al.* 2004, p. 60). Adult males generally return to the same lek to mate throughout their lives (Dunn and Braun 1985, p. 625). Females typically nest in the same area each year (Young 1994, p. 42). If females do not have a successful nest, they may move nest location further (each year) compared to successful females (Connelly *et al.* 2011, p. 60). Yearling males visit more than one lek in their first breeding season, suggesting an age-related period of establishment (Connelly *et al.* 2011, p. 60). Of 11 yearling GRSG males in northern Colorado, all visited more than one lek, compared to 3 of 11 adult males visited more than 1 lek (Emmons and Braun 1984, p. 1026).

Females rear only one brood per season, although a few females will re-nest if the first clutch is lost during early laying or incubation (Davis *et al.* 2015, p. 5). Males do not care for young and do not provide resources to the female, the eggs, or the chicks, such as nesting or foraging sites (Young *et al.* 2015, p. 9). Only 10 to 15 percent of males on a given lek successfully breed each year, as multiple females may breed with the same male at each lek (Young 1994, p. 103). Yearling males rarely attend leks until the peak of the breeding season and are often chased away by adult males across leks, often driven completely from the breeding area. This often means that yearling males do not breed (Young *et al.* 2015, pp. 8–9). Sex ratios of populations may vary, but the sex ratio at the San Miguel Basin population was one male to 2.13 females at leks (Stiver *et al.* 2008, p. 477), while average long-term wing data estimates 1.6 females to every male (GSRSC 2005, p. 43).

In the Gunnison Basin, clutch sizes ranged from 5 to 8 eggs, with an average of 6.8 eggs (Young 1994, p. 37), which is similar to the average of 6 eggs per clutch (Stanely *et al.* 2015, p. 64). Nest success can be highly variable and often depends on weather, habitat quality, and risk of predation, among other factors. Nest success ranged from 21.4 percent to 60.1 percent in the Gunnison Basin and San Miguel populations (Davis 2012, p. 1). Chick survival likely also varies between populations, with chick survival likely lower in the satellite populations, for example, with a much lower chick survival in San Miguel compared to Gunnison Basin (Davis 2012, pp. 35–37, 44). No chicks in San Miguel survived to 30 days during a 4-year study, which was likely due to the small sample size (n=8), but the chick survival rate in Gunnison Basin was 0.468 (n=290). Although Gunnison Basin chicks did show higher recruitment and survival, the chick survival rates were declining over the course of the study (Davis 2012, p. 38). Survival also increased with the age of a chick (Davis 2012, p. 35). Monthly juvenile survival rates from 31 days of age to the start of the first breeding season (April 1) were variable around 0.75 to 0.80 until September and remained at 1.00 from September to April (Davis 2012, p. 47). This is similar to survival patterns of adults and yearling GUSG; however, adult survival is much higher than chicks and juveniles. Male and female adult/yearling GUSG monthly survival stayed around 0.95 throughout the year, except in March when male survival dropped to around 0.80 and female survival dropped to around 0.90 in April (Davis 2012, p. 71). Low chick and juvenile survival rates affect our HMCs, and are much more intensive to study. We do not have current, range wide data on chick and juvenile recruitment and survival rates.

2.4 RANGE AND DISTRIBUTION: HISTORICAL AND CURRENT

Historically, GUSG occurred in southwestern Colorado, northwestern New Mexico, northeastern Arizona, and southeastern Utah (Schroeder *et al.* 2004, p. 370) (Figure 5). Today, GUSG are found only in eight populations in southwestern Colorado and southeastern Utah (Figure 4). The eight GUSG populations in southwestern Colorado and southeastern Utah are:

- Gunnison Basin;
- Poncha Pass;
- Crawford;
- Cerro Summit-Cimarron-Sims Mesa;
- Piñon Mesa;
- San Miguel Basin;

- Dove Creek; and
- Monticello.

These eight small GUSG populations occur in eight counties in Colorado and one county in Utah (Figure 4). The Gunnison Basin population is largest population and has the largest quantity of occupied habitat, covering an estimated 239,641 ha (592,168 ac) (50 FR, p. 69195). Poncha Pass, to the east of the city of Gunnison, is the smallest population and has the least amount occupied habitat, covering 11,234 ha (43.4 mi²). Gunnison Basin supports approximately 85 percent of the breeding birds for the species and 65 percent of the occupied habitat. The remaining 15 percent of the individuals are distributed among the remaining populations, which comprise 35 percent of the overall occupied habitat. Of the eight populations, the San Miguel Basin contains six subpopulations that occupy discreet habitat areas (Figure 4).

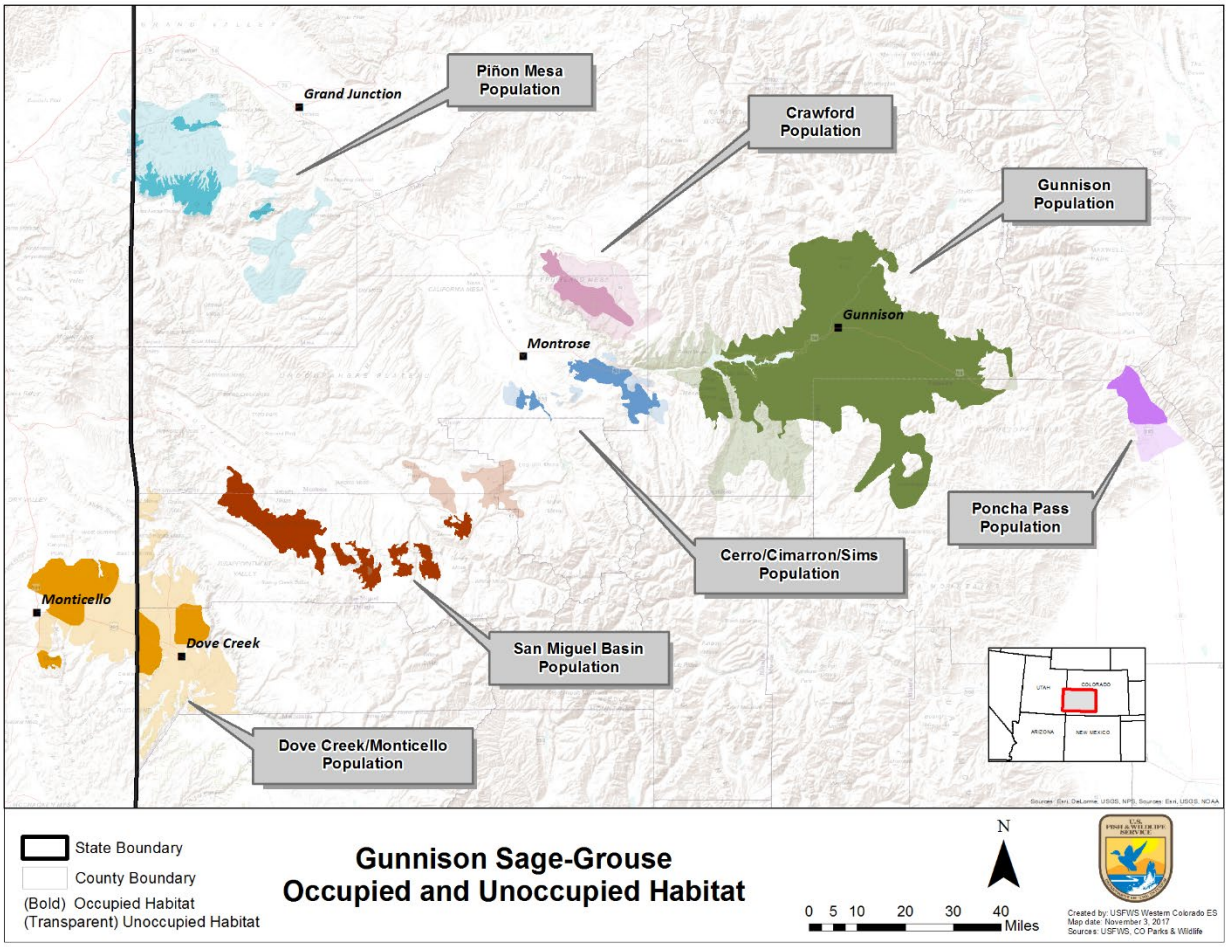


Figure 4. Current distribution of the eight recognized populations of GUSG in Colorado and Utah. For our SSA analysis, we considered the Dove Creek and Monticello populations as two populations. The lighter shading indicates areas that contain the appropriate biological and physical features for GUSG survival, yet GUSG do not occupy them. The darker colors indicate occupied habitat where breeding takes place or is known to have taken place.

The eight populations of GUSG occupy six different ecoregions, which are areas delineated by common geology, landforms, soils, vegetation, climate, land use, wildlife, and hydrology (EPA 2018). We summarize these ecoregions to highlight ecological differences between the eight GUSG populations, which influence the resources and demographic factors that we later identify, as species needs and drive current condition. We will reference these ecoregion descriptions when evaluating current condition.

The Gunnison Basin population is the only population occurring almost entirely in the Southern Rockies ecoregion, Sagebrush Park. Dominant physiographies in this ecoregion are high intermontane valleys, moderate gradient perennial streams with cobble, gravel, and sandy substrates. Primary vegetation includes Wyoming big sagebrush, mountain big sagebrush, black sagebrush, western wheatgrass, bottlebrush squirreltail, and elk sedge, with areas of bunchgrasses including Arizona fescue and mountain muhly (EPA 2006, 21i.). Soils in the Gunnison Basin primarily fall into the Mollisols order, meaning soils are dark, have relatively high amounts of organic matter, are quite fertile, and characteristically formed under grass in climates that have a moderate to pronounced seasonal moisture deficit (USDA 1999, p. 555). These soils are also generally found between the Aridisols of arid environments and Alfisols of more humid environments (USDA 1999, p. 555).

Poncha Pass, to the east of Gunnison Basin, falls almost completely in the Arizona/New Mexico Plateau ecoregion, San Luis Shrublands and Hills, which is on the periphery of mid-elevation forests, and the Southern Rockies. This ecoregion contains low mountains, hills, mesas, and foothills ranging in elevation from 7,900 to 9,100 feet. Common soils here are a mix of Aridisols and Mollisols. Aridisols are soils in which water is not available to mesophytic plants (plants not adapted to dry or wet environments) for long periods (USDA 1999, p. 329). Because of the imbalance between evapotranspiration and precipitation, many Aridisols contain salts (USDA 1999, p. 329). This ecoregion also contains Mollisols soils, as described for the Gunnison Basin. Mean annual precipitation is 10 to 14 inches. Natural vegetation includes shrublands, grasslands, and piñon-juniper woodlands at highest elevations. Species include big sagebrush, rubber rabbitbrush, winterfat, western wheatgrass, green needlegrass, blue grama, and needle-and-thread (EPA 2006, 22a).

Three populations (Piñon Mesa, Crawford, and CSCSM) and three subpopulations (Hamilton Mesa, Miramonte Reservoir, and Gurley Reservoir) of the San Miguel population fall in the Colorado Plateau ecoregion of Semiarid Benchlands and Canyonlands. Benches, mesas, cuestas, alluvial fans, hillslopes, cliffs, arches, and canyons characterize this ecoregion, although not all of these features occur in all of these populations (EPA 2006, 20c.). Soil are arid-type soils (Entisols, Aridisols, and Mollisols), often slightly saline and/or calcareous, and mineral soils (NRCS 1999, pp. 421, 555). Natural vegetation includes piñon-juniper woodland, Gambel oak woodland, and sagebrush steppe with black sagebrush, winterfat, Mormon tea, fourwing saltbrush, shadscale, galleta grass, and blue grama (EPA 2006, 20c.).

The Dry Creek Basin of the San Miguel population is the westernmost subpopulation of the San Miguel population and primarily falls within the Shale Deserts and Sedimentary Basins ecoregion in the Colorado Plateau (EPA 2006, 20b.). The physiography of Dry Creek Basin is

nearly level, with some rolling plains and basins, with benches, low rounded hills, and badlands (EPA 2006, 20b.). The elevation is around 1,940 m (6,365 ft.) above sea level and contains diverse soil groups including Entisols, Aridisols, and Mollisols. Entisol soils occur in areas of recently deposited parent materials or where erosion rates are faster than rates of soil development, such as dunes, steep slopes, and floodplains (USDA 1999, p. 389). Aridisols are too dry for growth of mesophytic (plants adapted to moderate moisture) plants and often accumulate gypsum, salt, and calcium carbonate (USDA 1999, p. 329). Mollisols are more fertile and typically contain more organic matter compared to Aridisols and Entisols.

The two eastern-most subpopulations of the San Miguel Basin (Beaver Mesa and Iron Springs) occur in the Southern Rockies ecoregion Sedimentary Mid-Elevation Forests. These subpopulations are near the ecoregion border of Semiarid Benchlands and Canyonlands described previously, so some mixing of physiography, soils, and vegetation is likely. Additionally, there are some small overlaps of the Piñon Mesa, Gunnison Basin and CSCSM occupied ranges onto this ecoregion. Physiography in the Sedimentary Mid-Elevation Forests ecoregion contains low mountain ridges, slops, and outwash fans. There are moderate to high gradient perennial streams with boulder, cobble, and bedrock substrates (EPA 2006, 21f.). Primary soil orders include Alfisols, Entisols, and Mollisols (EPA 2006, 21f.). Alfisols tend to form a belt between the Mollisols if grasslands and other soil types in climates that are more humid. Mollisols are typically more fertile types of soils, occurring in semiarid to moist areas (USDA 1999, pp. 163, 555). Entisols are soils that are essentially unaltered from their parent material (mineral), thus showing no horizons or layers (USDA 1999, p. 389). Natural vegetation in this ecoregion is Ponderosa pine forest, Gambel oak woodland, and aspen forest, with areas of mountain mahogany and two-needle piñon pine. Shrub vegetation includes antelope bitterbrush, fringed sage, serviceberry, and snowberry and understory grasses of Arizona fescue, bluegrass, Junegrass, needlegrasses, mountain muhly, pine dropseed, and mountain brome (EPA 2006, 21f.).

The two western-most populations, Monticello (Utah) and Dove Creek (CO), primarily occur in the Colorado Plateau ecoregion, Monticello-Cortez Uplands. This ecoregion is nearly level to rolling plains and basins containing stream terraces, alluvial fans, and low rolling hills and ridges (EPA 2006, 20a.). Elevation in this ecoregion ranges from 6,000 to 7,300 feet. Primary soil types here fall in the orders of Aridisols, Alfisols, and Entisols (EPA 2006, 20a.) and precipitation ranges 10 to 15 in per year. Natural vegetation includes sagebrush steppe and associated grasses, with scattered piñon-juniper woodland. The dominant species include Wyoming big sagebrush, western wheatgrass, and Indian ricegrass (EPA 2006, 20a.). Land use and land cover are primarily dryland cropland with some areas of irrigated cropland, shrubland, and rangeland.

2.4.1 Historical Range and Distribution

The occupied range of GUSG has contracted from historical levels; GUSG experienced a massive contraction of its occupied range since the 1900s, primarily due to habitat loss. GUSG now occupies an estimated 10 percent of its historical range (Schroeder *et al.* 2004, p. 370). Conversion of sagebrush habitat to agriculture or residential and commercial development since the early 1900s has caused much of the GUSG range contractions.

The GUSG rangewide conservation plan (RCP) (GSRSC, 2005) provided an assessment of the historical range contraction for the species. The RCP adapted the results of Schroeder *et al.* (2004) to clarify areas of where it is unclear whether it was occupied by GUSG or GRSG, some extensions of potential habitat providing connectivity, and some areas of uncertain historic occupancy or habitat suitability based on ground-truthing and satellite imagery (Figure 5). Schroeder *et al.* (2004, p. 370) estimated GUSG historical (pre-settlement by Euro-Americans) range to have been 4,652,100 hectares (ha) (17,961 square miles (mi^2)). It is likely the distribution of the species has always been discontinuous because of the natural fragmentation of sagebrush habitats and separation by river valleys and high, forested mountains (Hupp and Braun 1991, p. 255; Young 2000, p. 446); however, there has still been considerable loss of sagebrush habitat in the last century.

There are no mentions of sage-grouse in early traveler and explorer notes in New Mexico and the lack of published records or observations suggest sage-grouse were uncommon to rare well before 1900 (Braun and Williams 2015, p. 207). Phillips *et al.* (1964, cited in Schroeder *et al.* 2004, p. 369) considered the range of sage-grouse in Arizona to be hypothetical. In addition, records indicate grazing was so severe in Arizona in the 1870s and 1880s that the sagebrush and grass species were permanently altered (Schroeder *et al.* 2004, p. 369).

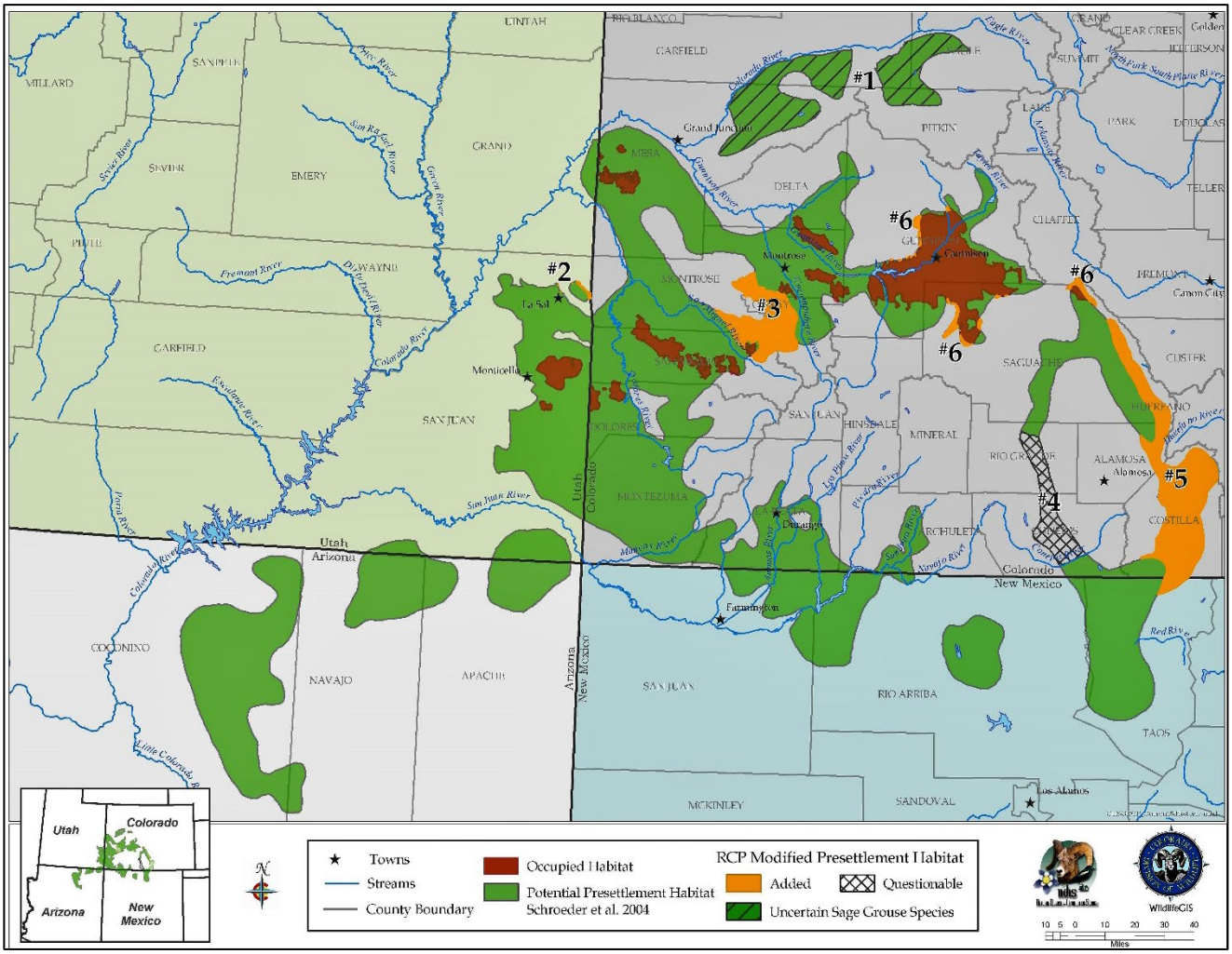


Figure 5. Current and pre-settlement distribution of Gunnison sage-grouse (GUSG RCP 2005, p. 33). The current, occupied range is shown in brown. Pre-settlement distribution is based on Schroeder et al. 2004 (p. 368) which used information last updated in 1999. (#1) indicates uncertainty in distinguishing between pre-settlement GUSG and GRSG populations; (#s 2, 3, 5, and 6) are added areas based on CPW/UDWR mapping of potential (unoccupied) habitats and connectivity corridors; and (#4) indicates an area unlikely to have previously supported GUSG due to a lack of sagebrush and lack of records of GUSG.

Rogers (1964) reported on the presence of sagebrush and sage-grouse in Colorado in the 1950s and 1960s. They reported sage-grouse in the southwestern Colorado counties of Archuleta, Delta, Dolores, Eagle, Garfield, Gunnison, La Plata, Mesa, Montezuma, Montrose, Ouray, Pitkin, Saguache, and San Miguel. They also suggested the eastern slope counties of Alamosa, Chaffee, Lake, Conejos, Costilla, Rio Grande, and possibly Huerfano (Rogers 1964, p. 9). Braun *et al.* (2014, p. 209) presumes these occurrences to be GUSG, however, we consider three of these counties (Eagle, Pitkin, and Garfield Counties) are of an undetermined species due to the very close proximity to GRSG and geographical barriers to other GUSG populations. Rogers' (1964, p. 10) historical range of sage-grouse map, shows a more contracted range in southwest

Colorado compared to Schroeder *et al.* (2004, p. 370), however it may not account for areas providing connectivity between populations.

In the early 1900s, the distribution of GUSG was patchy and frequently defined by linear strips along riparian areas and intermountain basins in Colorado (Braun *et al.* 2014, p. 213). Areas revisited in the 1960s indicate dominant plant species as sagebrush, Gambel's oak, serviceberry, and snowberry (Braun *et al.* 2014, p. 213). Most of the range was badly overgrazed in 1875, and a reduction in sage-grouse numbers followed a decrease in the range of sagebrush (Rogers 1964, p. 13). In the following decades, common practices included mowing, burning, and spraying sagebrush to re-seed with the intention of improving the grasses and vegetation. Food availability to sage-grouse improved on reseeded areas, but cover, insects, and winter food were all reduced due to the reduction in sagebrush (Trueblood as cited in Rogers 1964, p. 14).

Rogers (1964) and Braun *et al.* (2014) provide observations and evidence of substantial modifications to GUSG habitat and resulting declines of GUSG populations from human actions since the early 1900's. In 2014, the estimate of occupied habitat was approximately 379,500 ha (1,465 mi^2) (79 FR 69332, p. 69193; GSRSC 2005, pp. 36-37) which is about 10 percent of the potential habitat of estimated pre-settlement distribution (Schroeder *et al.* 2004, p. 370). Habitat loss is primarily attributed to conversion to irrigated and dry farmland with much of this loss occurring prior to 1958, and 20 percent lost between 1958 and 1993 (Oyler-McCance *et al.* 2001, p. 323). Historically, Dove Creek, Monticello, San Miguel, Crawford, and Piñon Mesa all had much more sagebrush habitat and probably larger GUSG populations. The loss and fragmentation of habitat has led to the current isolation of these populations with relatively low amounts of gene flow.

Large reservoir development also contributed to the loss of thousands of acres of historical GUSG habitat in the Gunnison Basin. Three reservoirs were constructed in the mid to late 1960s (Blue Mesa and Morrow) and mid-1970s (Crystal). These projects continue to provide water storage, and to a certain extent, facilitate agricultural activities throughout the range of GUSG. The construction of Miramonte Reservoir also resulted in the loss of hundreds of acres of sagebrush habitat in the San Miguel population. Crawford and Gould reservoirs affected hundreds of GUSG habitat acres in the Crawford population area. Urban growth from the 1970s through the 1990s resulted in extensive private land use conversion with GUSG habitat (Riebsame *et al.* 1996).

In addition to the rangewide loss of sagebrush habitat, hunting was a significant pressure acting on GUSG for much of the 1900's. The first licensed sage-grouse season in Colorado was in 1905 (extended a month more in August 1907), from September 1 to October 20, with a daily bag limit of 25 and a possession limit of 50 birds (Rogers 1964, p. 9). By 1911, the earlier opening season was responsible for GUSG decline (1964, p. 9), which included greater and Gunnison sage-grouse populations. Further records in the early 1900s indicate intense hunting pressure from hunters killing birds beyond bag limits and outside of the open season (Rogers 1964, p. 11).

2.5 INDIVIDUAL RESOURCE NEEDS

Here, we describe the ecological resources that each GUSG life stage (chicks, juveniles, immatures, subadults, and adults) need to breed, feed, and shelter in order to complete each stage of its life cycle. An obligate of sagebrush ecosystems, all GUSG life stages need sagebrush for food and shelter (Table 1). Additionally, all life stages feed on invertebrates and forbs. Yearling/subadults and adults also need leks to successfully breed. Below, we describe these resources in more detail and Table 1 summarized the resource needs by life stage.

Table 1. Resources needed by each GUSG life stage to breed, feed, and shelter.

GUSG Life Stage	Resource Need	Function & Description of the Resource Need
Chicks (hatch-3 weeks) ~ June - July	**Invertebrates** **Forbs** **Sagebrush**	Chicks feed immediately after hatch, invertebrates dominate their diet, and forbs provide key habitat for invertebrates. Surrounding sagebrush provide habitat for invertebrates and shelters chicks.
Juveniles (4–12 weeks) ~ June - August	**Invertebrates** **Forbs** **Sagebrush**	Juvenile GUSG transition from an invertebrate dominated diet to include forbs.
Immature (12–36 weeks) ~ Sept - March	**Invertebrates** **Forbs** **Sagebrush**	This life stage is present from September to March, meaning they over-winter (spend the winter) in sagebrush, so sagebrush is their primary food source.
Yearling/Subadults (1 year) 1st lekking season to just prior to their 2nd	**Invertebrates** **Forbs** **Sagebrush** **Lek site**	Same as adult. Yearling females will often breed their first year; males will attempt to but are usually not successful. They may travel to other leks.
Adults (21 months+) 2nd lekking season and older	**Invertebrates** **Forbs** **Sagebrush** **Lek site**	Sagebrush is the primary food source November to April, forbs and insects commonly eaten in summer. In fragmented habitats, they will also feed on cultivated fields of alfalfa, wheat, and beans. Sagebrush canopy cover up to 30 percent for nesting and winter habitat. For mating displays, area of low cover is needed, adult males show site fidelity by returning to same lek annually.

2.5.1 Sagebrush: Feeding and Shelter

Throughout their life cycle, GUSG depend on a variety of shrub-steppe habitats and are obligate users of several sagebrush species. Individuals rely on ecosystems with relatively continuous and healthy sagebrush stands for food and cover throughout the year, while grasses and forbs in the understory provide cover and food during nesting and early brood-rearing (Coggins 1998, pp. 30-31; Connelly *et al.* 2000, p. 971). GUSG use a mosaic of sagebrush habitats throughout their range, including sagebrush along riparian areas, and intermountain basins, characterized by several sagebrush species and mountain shrubs including but not limited to Gambel's oak, serviceberry, and snowberry (Young *et al.* 2015, p. 4).

Sagebrush contains toxic chemical compounds that deter herbivory by sage-grouse and other herbivores. However, sage-grouse are one of the few herbivores with coevolved adaptations that allow them to eat sagebrush, despite these toxins (Oyler-McCance 2018). The digestive system of sage-grouse is uniquely adapted to eat sagebrush leaves (Barber 1968, p. 2) and birds selectively feed on sagebrush species with higher nutritive value and/or lower toxins (Frye et al. 2013, p. 312; Remington and Braun 1985, all). This is an important physiological adaptation, because during the winter when other food sources are not available, GUSG feed almost entirely on leaves of several subspecies of big sagebrush, black sagebrush, little sagebrush, and winterfat (*Krascheninnikovia lanata*) (Young *et al.* 2015, p. 5).

2.5.2 Mesic Habitats: Feeding and Shelter

During the early summer/brood-rearing season, mesic (wet) areas within or near sagebrush habitats provide important habitats for females and chicks. Juveniles and all other life stages use mesic habitat that provide abundant forbs and invertebrates, especially once those resources are no longer available in the nesting area. Mesic habitats and drainages also provide cover from predators (Young *et al.* 2015, p. 5).

2.5.3 Forbs and Insects: Feeding

Throughout the rest of the year, in the spring, summer, and fall, GUSG eat sagebrush, forbs, and insects. Breeding females consume succulent forbs in the sagebrush understory, as available, to obtain calcium and other nutrients for egg production. Male and female GUSG will also continue to consume sagebrush and forbs, including sprouting alfalfa and the flowers of pinto beans (Schroeder *et al.* 1999, p. 5; Young *et al.* 2015, p. 5). In the summer, adult GUSG feed on leaves of winterfat, forbs, yarrow, balsam root, milkvetch and low growing succulent, native and exotic forbs. GUSG may opportunistically feed on nonnative plants such as alfalfa, clovers, pinto bean sprouts and flowers, and soft wheat kernels. In the first three weeks after hatch chicks feed almost exclusively on insects and will imitate hens by picking at some buds and blossoms (Young *et al.* 2015, p. 13).

2.5.4 Leks: Breeding

Leks are the Breeding areas where male GUSG make mating displays (strut) to attract females. Female sage-grouse establish leks in valley bottoms, basins, along ridges, and on broad sloping expanses, which may include agricultural fields and former crop fields that were historically sagebrush dominated (Young *et al.* 2015, p. 4). Leks generally have good acoustic qualities and are relatively flat, open areas in or near sagebrush habitat.

2.5.5 Seasonal Migration for Suitable Habitat

Most GUSG stay in the same area year-round, but GUSG may also may migrate up to 40 km (24.9 mi) between winter-use, breeding, and nesting areas (Hupp and Braun 1989), within the same population. Seasonal migration patterns of GUSG appear to vary between individuals and populations based on the available habitat and habitat quality within their home range. In general, snow depth drives GUSG migrations in the fall and early winter, with birds conglomerating into flocks and moving downward from higher elevations to lower elevation or more protected areas, generally on west- and south-facing slopes (Young *et al.* 2015, p. 3). In the Gunnison Basin, winter movements are driven by the availability of sagebrush above the snowline. Birds move to ridge tops, slopes, or to areas where snow does not accumulate over 50 to 60 cm (19.7 to 23.6 in) which is most often found in drainages (Hupp and Braun 1989, pp. 828-829).

In the spring, GUSG migrate to their breeding areas, migrating in the opposite direction from their fall and winter migrations. Based on the local availability of sagebrush, winter snow depth, forbs, and insects, individuals may stay within 5 km (3.1 mi) of a lek (Dove Creek and Crawford GUSG individuals) year-round, or move to lower elevations during the winter (San Miguel Basin and Piñon Mesa) (Commons 1997, all).

2.5.6 Summary of Individual Resource Needs

Individual GUSG need sagebrush, invertebrates, forbs, and leks in order to complete each stage of the species' life cycle. Additionally, during the brood-rearing season, females and chicks rely on mesic areas, often adjacent to sagebrush stands, for shelter and food. Leks, open areas surrounded by sagebrush, are needed for breeding. In general, sagebrush is the common resource need across life-stages and function, providing food and shelter throughout the year, and an understory of forbs and grasses during the spring and summer.

The RCP (GSRSC 2005, pp. 27-31) segregated habitat requirements into three main habitat types based on their season of use by GUSG:

1. **Breeding Habitats** – Breeding habitat includes lekking (leks), pre-laying female, nesting, and early-brood rearing habitats. Leks are usually located in small open areas adjacent to stands of sagebrush. The amount of habitat needed for males to strut can vary greatly. Displaying males may abandon leks if there are tall shrubs, trees, or other

obstructions nearby. Leks are usually located near nesting habitat and areas that females frequent.

Often, bushes used by females for nesting are taller than surrounding shrubs. Canopy cover around nests ranges from 15 to 38 percent, with sufficient grasses and forbs in the understory, used by females and the chicks for food and shelter. In southwestern Colorado, GUSG females nested in areas with grass cover of 24.9 percent and forb cover of 17.6 percent, and grass and forb heights were 4.0 in and 1.6 in, respectively.

Early brood-rearing habitats are relatively close to nest sites, but individual females with broods may move large distances. Early brood-rearing habitats typically feature a high diversity of plant species. In early summer, females with broods remain in sagebrush uplands as long as the vegetation remains succulent, and the broods may move to wet, mesic meadows as vegetation desiccates.

2. **Summer Habitat –** Summer habitats are used during the summer and late fall by males, non-brooding females, females with broods, and juveniles. Summer habitats feature high elevation mesic areas, croplands, wet meadows, and riparian areas. GUSG continue to use these areas into the fall and slowly transition to a sagebrush-dominated diet during the winter, coinciding with the fall migrations.

3. **Winter Habitat** – Winter habitat features sagebrush available above accumulated snow. Winter habitat is used by segregated flocks of males and females, as winter weather triggers movements into winter habitat. Winter habitat use depends on snow depth and availability of sagebrush, which is used almost exclusively during the winter for both food and cover. To escape extreme winter conditions, sage-grouse may burrow into "snow roosts," or small cavities dug in accumulated snow. In the Gunnison Basin, most GUSG fed during the winter in drainages and on slopes with south or west aspects (Hupp and Braun 1989b).

Although these are three general seasonal habitat types, they may be indistinguishable from each other if they are close together. Regardless of the variation in seasonal habitat types, GUSG habitats are best described by large contiguous expanses of mature big sagebrush (*A. tridentata*).

GUSG use extensive landscapes throughout the year because they need a diversity of seasonal habitats and have specialized dietary requirements (GSRSC 2005, p. 26). The quality and quantity of these habitats dictates the resources available to individual GUSG, which GUSG need to complete each life stage of the life cycle. Therefore, GUSG habitats can be characterized according to their quantity and their quality (Table 2).

Table 2. Individual GUSG need habitats with sagebrush, insects, forbs, grasses, mesic areas, and leks in order to breed, feed, and shelter. These resources make up GUSG habitats, which can be characterized by their quantity and quality.

Habitat Factors	Resource Need	Metric
Habitat Quantity	Sufficient seasonally and geographically specific quantity and quality of sagebrush to support breeding, feeding, and sheltering.	Acres of sagebrush habitat.
Habitat Quality	The ability of the environment to provide conditions appropriate for feeding, breeding, and sheltering.	Sufficient available sagebrush with an understory of grasses and forbs for feeding, breeding, and sheltering.

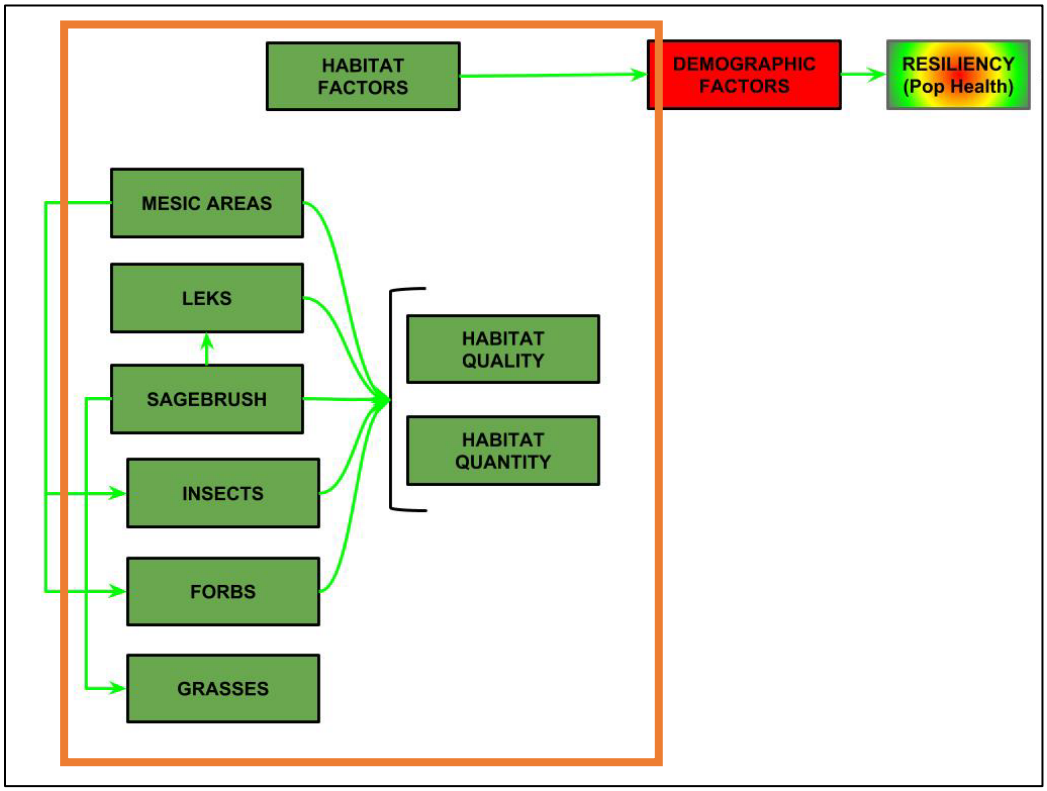


Figure 6. Conceptual model of the habitat factors (green boxes), needed by individual GUSG to breed, feed, and shelter, and complete each life stage of its life cycle.

2.5.7 Uncertainties Regarding Individual Needs

Overall, individual needs of GUSG are well understood and easily identified. However, the precise quality and quantity of these resources needed by GUSG are unknown, because GUSG birds have been observed in habitat with various vegetation.

2.6 POPULATION NEEDS

In this section, we evaluate what GUSG populations need to be resilient, or able to withstand stochastic events, or fluctuations in environmental conditions. The measure of resiliency is based on a population's ability to withstand or recover from environmental or demographic stochastic events, such as population declines and changes in the availability of resources. These demographic or distribution factors that populations need to be resilient are influenced by the presence of resource and habitat factors, which correspond to the needs of individual GUSG, identified above (Figure 7, below).

In general, resilient populations have a sufficient population size, growth rate, or other demographic factors, to bounce back, or recover, from stochastic events. Stochastic events that may affect the eight populations of GUSG may include drought, wildfires, and weather such as harsh winters, late freezes, and high temperatures. Table 3 summarizes these GUSG population-level needs for resiliency and metrics that could be used to evaluate the population need.

Table 3. Demographic factors that GUSG populations need to be resilient are shown below. Resiliency refers to the ability of a population to withstand stochastic events. Resiliency is the demographic ability to absorb and bounce back from disturbance and persist at the population scale (Smith et al. 2017, p. 8). The population-level needs for resilient GUSG populations include population size, recruitment, survivorship and the quantity and quality of habitats.

Demographic Factors	Need for Resiliency	Metric
Population size	Sufficiently large population size to withstand periodic population crashes and avoid inbreeding depression.	High male count (HMC)
Recruitment	Successful reproduction and addition of new individuals into the population.	
Survivorship	Survival of GUSG individuals to adulthood and reproductive age.	
Population Growth Rate	Sufficient population growth rate to maintain or increase population size	
Connectivity	Connectivity between populations to promote the exchange of genes	Distance between populations

For GUSG, all populations require recruitment and survivorship to maintain sufficient population sizes and sufficient growth rates. Sufficient habitat quantity and quality, that provide the resources needed by individual GUSG to breed, feed, and shelter, are directly linked to the fulfillment of the demographic requirements, as shown in Figure 7, below.

2.6.1 Population Size

Sufficient population size is important to avoid inbreeding depression, loss of genetic variation, and accumulation of new mutations (GSRSC 2005, p. 109). Sufficient population size is also needed so that populations are resilient, or able to withstand stochastic events. The RCP developed population target numbers for each population of GUSG, based on current and potential habitat, potential habitat improvements, and conservation needs (GSRSC 2005, p. 30).

2.6.2 Recruitment

Recruitment measures the amount of individuals being added to a population through reproduction or migration. Sufficient recruitment of GUSG is essential to population resiliency in order to maintain sufficient population sizes.

2.6.3 Survivorship

Survivorship is the measure of the number of GUSG individuals in a population surviving to adulthood and able to reproduce. Survival rates for GUSG have been difficult to measure because evidence suggests rates of survival are different between life stages and sex. However, this helps indicate at which life stages survival is most important maintaining sufficient population sizes and resilient populations.

2.6.4 Connectivity

Connectivity represents the ability of individual GUSG to move among populations, and is measured by suitable habitat availability between populations as well as distance. Low inter-population movement and high levels of nest failure affects population resiliency by reducing the level of genetic heterozygosity.

2.6.5 Population Viability Analyses

There have been multiple efforts to assess viability of GUSG since 2004. In 2004, Miller (GSRSC 2005, p. G-21) looked at the extinction probability compared to the population size, modeled for 25 and 50 years using a range of growth rates. Female GUSG reproductive success and chick mortality were the driving demographic measurements. The model also included a catastrophic, once in a hundred year 3-year drought that increased chick mortality to 90 percent by the third year. Under the assumed conditions of positive population growth, and an extinction probability threshold of 5 percent over 50 years, a population could be considered “secure” if they maintain 500 birds (adults/yearlings). GUSG populations with less than 30 to 40 individuals were not considered viable. Even if these populations showed positive growth rates, environmental stressors such as infrequent but severe drought and fluctuations in recruitment and survival, these populations are at very high risk (GSRSC 2005, pp. G1-G40).

Garton (2005) provided additional insight into historic patterns of GUSG population change for the Service to consider in the listing decision. This analysis looked at long-term lek counts from 1957-2005 and compared to near-term lek counts from 1995-2005. For individual populations, it appears that Garton finds them above a minimum viable population size if they have been increasing over the long-term, regardless of the actual population size. Population viability is more influences by the population trend rather than theory. Garton (2005) said the Gunnison Basin population was stable, Piñon Mesa was probably stable with high variation, San Miguel was fairly stable trend to rapidly declining, Crawford had a flat population trend, Monticello had a three-fold decline from 1976 to 2005 and very mixed results, and there was no assessment for Dove Creek or Poncha Pass (Garton 2005, pp. 6-7).

Davis (2012) conducted a PVA of the Gunnison Basin and San Miguel populations (including the sub-populations of San Miguel) and found that reduction in juvenile recruitment was a limiting factor in viability. Three other demographic metrics showed merit as management targets based on Davis' results including adult survival, chick survival, and adult nest success (Davis 2012, p. 95). Over the six-year course of their study, chick survival was near zero in San Miguel which caused a dramatic difference in the population projections (Davis 2012, p. 87). The Gunnison Basin was projected to decline towards extirpation in 30 years, whereas San Miguel trended towards extirpation in 15 years with high amounts of variation (Davis 2012, p. 106). Both populations experienced declines during the time of the study, which influenced the projections, and if the study had been conducted a few years earlier or later, there may have been different trends (Davis 2012, p. 92).

2.6.6 Summary: Population Needs

In order to be resilient, GUSG populations need a sufficient population size, recruitment, survivorship, growth rate, and connectivity to other populations (Figure 7). Low population sizes can be the result of low recruitment and survivorship, therefore a low growth rate. A minimum population size is necessary to ensure successful mating and maintaining genetic diversity. Connectivity between populations can help maintain genetic diversity; however, this can also be limited by small population sizes and poor habitat conditions.

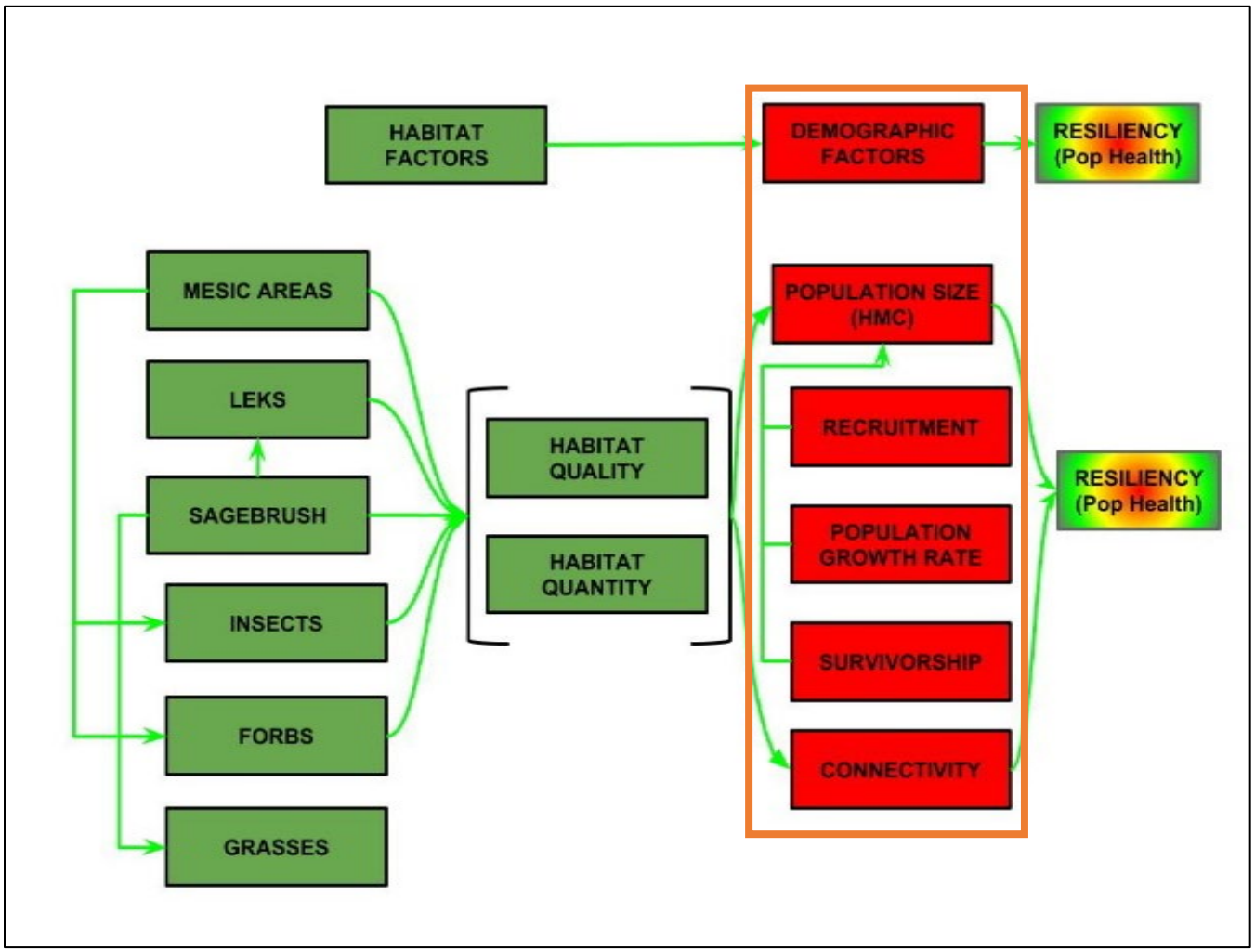


Figure 7. Conceptual model of the habitat and demographic factors that GUSG populations need to be resilient. According to our core conceptual model, the habitat factors (green boxes) of habitat quality and quantity directly influence the demographic factors such as population size and growth rate, that GUSG populations need to be resilient or better able to withstand stochastic events.

2.6.7 Uncertainties and Assumptions Regarding Population Needs

We currently do not understand what the minimum amount of movement among populations that could naturally occur or be achieved through translocations, and maintain healthy genetic diversity in all populations. In addition, minimum viable population sizes are unknown. In multiple populations, recruitment and juvenile survival appear to limit population size and/or growth, but we do not know what recruitment/survival rates are per population and what minimum amount of recruitment needs to happen for population growth.

2.7 SPECIES NEEDS

We evaluate the species' needs in terms of the resources and/or the circumstances that support the redundancy and representation of the species. We evaluate the redundancy of this species by the number and distribution of the populations. Having multiple populations distributed across the species range would spread the risk of a catastrophic event, such as prolonged, multi-year drought that affects multiple populations.

The number of GUSG populations and their distribution across the overall, occupied range supports redundancy. In other words, redundancy for GUSG is the number of populations and their distribution across the overall range. Having multiple populations distributed across the species range would spread the risk of a catastrophic event, such as prolonged, multi-year drought, affecting multiple subpopulations. For representation, the ecological, morphological, physiological, behavioral and genetic diversity across these populations describes the species' ability to adapt to novel biological and physical changes in its environment. In general, the species needs a sufficient number of resilient populations distributed across the overall range with ecological and genetic diversity in order to withstand catastrophes and adapt to environmental change. We describe the GUSG's needs for redundancy, and representation below, and summarize the key aspects in Table 4.

Table 4. Redundancy and representation are species-level metrics that, combined with the population-level metric of resiliency, support the viability of the species. Redundancy spreads risk among multiple populations or areas to minimize the risk due to catastrophes or large-scale, high-impact events. Representation uses diversity as a proxy for adaptive capacity (Smith et al. 2017, pp. 7- 8).

Species-Level Needs	Summary	Details
Redundancy	Resilient populations distributed across geographical areas reducing the influence of catastrophic events	Widespread to ensure all populations are not exposed to a single or series of catastrophic events
Representation	Having healthy populations distributed across the breadth of genetic and phenotypic diversity; maintaining evolutionary processes	Preserve the breadth of variation in biological traits and genetic diversity; maintain adaptability by ensuring populations occupy an array of environments.

2.7.1 Summary of Species Needs

We evaluate the viability of GUSG based on the presence of multiple (redundancy), self-sustaining (resiliency) populations distributed across the range of the species (redundancy), and their contributions to adaptive capacity of the species in the face of changing environmental conditions (representation). The species needs multiple (redundancy) self-sustaining (resiliency)

populations distributed across the species range (redundancy) in the representative units (representation) that are available now.

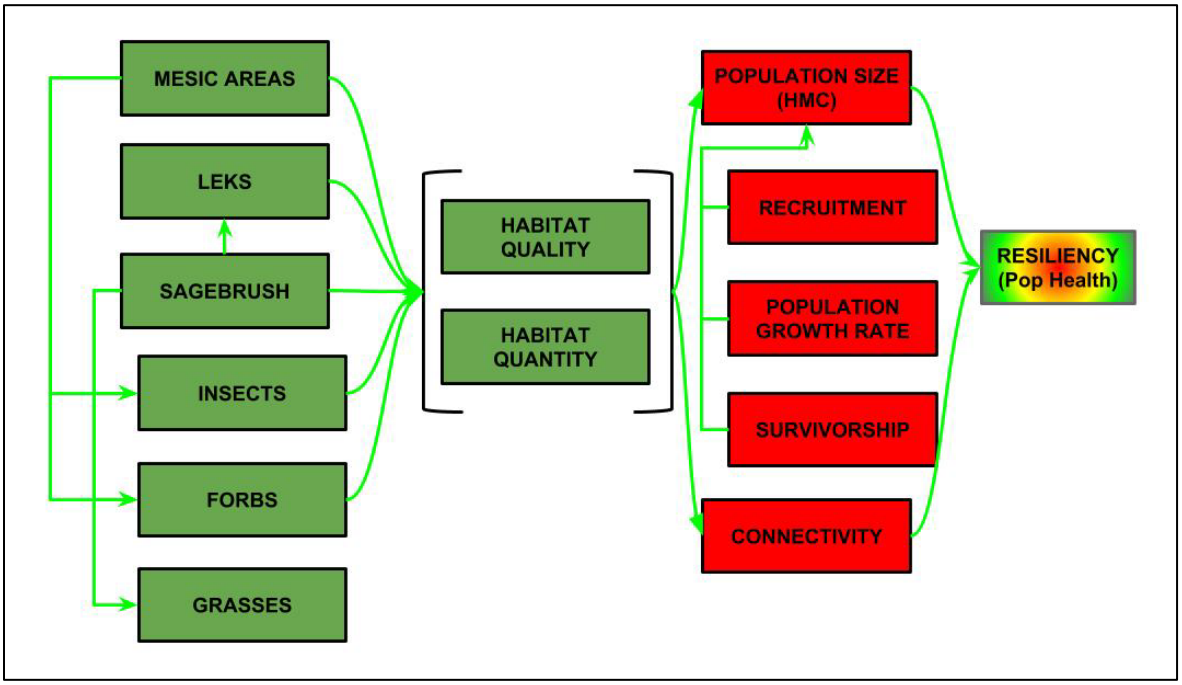


Figure 8. Conceptual model for the needs of individual GUSG (green boxes) and what GUSG populations need to be resilient..

Viability describes the ability of the species to persist with little management assistance. In order for GUSG to be viable, individuals need sufficient sagebrush, insects, forbs, and grasses to breed, feed, and shelter. Individual GUSG success in breeding, feeding, and sheltering influences the overall population. Therefore, for resilient populations to contribute to species viability, populations need recruitment and survivorship to maintain a positive or stable growth rate. Unless a single population is very large (like the Gunnison Basin) where genetic diversity is maintained through intra-population connectivity and sufficient numbers of individuals, connectivity among populations is necessary to avoid inbreeding depression and reduction in individual's fitness. Connectivity also contributes to the redundancy of the species, allowing movement to other populations in the possibility of catastrophic event. Multiple populations inhabiting areas of geographic variation could indicate an ability to adapt to change (representation).

2.7.2 Uncertainties Regarding Species Needs

It is unclear how much geographic and genetic variation between the eight populations contributes to the overall representation of the species. It is also unclear specifically how much genetic variation across the eight populations is needed.

3 CURRENT CONDITION

In this chapter, we describe the current condition of GUSG. First, we developed a condition category table to calibrate our terminology that we used to evaluate and describe the current condition for each of the habitat and demographic factors that we identified as needs in Chapter 2. Then we identified cause-and-effects, or the stressors and conservation efforts that influence the current condition of each population, and identified the pathway that these factors influence the resource needs. Then, using the condition categories, we evaluated the condition for each resource and demographic factor for each population. Then we used the three Rs to describe the species current condition.

3.1 ASSESSING POPULATION RESILIENCY: CONDITION CATEGORIES

Resiliency describes the ability of populations to withstand stochastic events. As described above under Species Needs, GUSG populations need a sufficient population size and growth rate, and individuals need habitats of sufficient quality and quantity in order for populations to be resilient. Populations with a sufficient quality and quantity of habitat and with a sufficient size and growth rate are more resilient, or are at lower risk from stochastic events. At the species-level, the species needs a sufficient number of these resilient populations distributed across the range in such a way to reduce risk from catastrophic events that may affect multiple populations, and to maintain genetic and ecological diversity, or representation.

3.1.1 Condition Categories for the Demographic Factors: High Male Counts

Scientific experts at our expert workshops indicated that high male counts (HMCs) are the best available data to evaluate demographic conditions of GUSG populations. HMCs were originally collected using different protocols in Utah and Colorado, but in 1996, protocols were standardized rangewide. Because there is annual variation in HMCs, we used the running 3-year average of HMC trends among all seven populations to assess population size and the actual counts in 1996 and 2019 to calculate population (HMC) growth rate. Recruitment, survivorship, and connectivity are population-level needs that we do not have consistent, rangewide information on, so these are discussed in our analyses of each population below.

GUSG and GRSG population sizes fluctuate overtime, sometimes cyclically, as evidenced by simultaneous declines and increases across all populations. To provide an indicator of long-term populations changes, we took the change in HMC from 1996 to 2018 divided by the number of years (23), as described in equation 1.1 ($\frac{\Delta N}{\Delta t} = rN$) in Gotelli (2008, p. 5), which is a simple model of exponential population growth. This population growth model indicates that the HMC growth rate ($\frac{\Delta N}{\Delta t}$) is proportional to r, the difference between birth and death rates, and that the HMC only increases if the birth rate (or addition of males to the population) exceeds the death rate (loss of males) (Gotelli 2008, p. 5). HMC data accounts only for strutting males counted at leks, and the growth rate is based on the longest range of consistent data collection available; therefore, depending on the years chosen to calculate ΔN the growth rate will change. There is uncertainty with this growth rate because it assumes the birth and death rates are constant over

time, it does not take into consideration other environmental factors, and only captures the males in a population.

Because this population growth rate is variable and dependent on just the counts in 1996 and 2018, and the number of years surveyed, we estimated that a high health population would exhibit growth greater than 0.5 over the 23-year period. Again, due to the natural fluctuations in populations, some decline in growth rate is normal, so we categorized a moderately healthy population as having a HMC growth rate between -0.5 and 0.5. Steeper rates of decline are cause for concern, so we categorized a low health population's HMC growth rate -0.5- to -1.0 and critical as less than -1.0 (Table 4).

For the 2005 RCP, CPW created population targets based on long-term population average and the potential for GUSG to expand into vacant or potentially suitable habitat (GSRSC 2005, p. 198). These were based on ten years of lek HMC data and vacant/potentially suitable habitat was based on GIS analysis. For the SSA and analysis of current conditions, we have taken the 3-year running average for each GUSG population and compared it to the estimated HMC derived from the population targets of the RCP. Using the equation below, and solving for *C*, the corresponding HMC for a population estimate (GSRSC 2005, p. 45).

$$Population\ Estimate = \frac{C}{0.53} + (\frac{C}{0.53}\ x\ 1.6)$$

A population target was not created for CSCSM, so we selected the 2005 modeled HMC capacity (GSRSC 2005, p. 256) of 28 males as the target, subtracting and adding 30 percent to get the low and high targets for this population.

Two sources of uncertainty here are that the population targets have not been updated to include ten more years of information and that the population estimate equation is imperfect. There have been studies that indicate HMCs can both under or overestimate a population and that the sex ratio is higher than 1.6, as used in the RCP (Stiver *et al.* 2008, pp. 474, 477; Davis 2012, p. 136). For future versions of the SSA and for recovery planning purposes, updating the HMC/population targets could help us understand what the habitat is capable of supporting and which populations need the most habitat improvements.

3.1.2 Condition Categories for the Habitat Factors: Quantity and Quality

Next, we developed categories for the habitat factors that we identified as species needs: habitat quality and quantity. For habitat quantity, we used the linear model equation in the RCP (GSRSC 2005, p. 191) to estimate how much habitat would be needed to support the HMC targets previously described. Our habitat quantity estimate essentially compares the actual available sagebrush habitat to the HMC target which was based on the maximum amount of possibly available habitat.

$$\hat{y} = \beta_0 + \beta_1(x_i)$$

Where $\hat{y}$ is the predicted number of males on leks, β_0 is estimated number of birds when there is 0 habitat (i.e.$x_i = 0$), β_1 is the slope (relationship of birds added to acres of habitat), and x_i is the amount of habitat for a given population. Our estimates differ from the sagebrush acres in the Rangewide Conservation Plan (GSRSC 2005, P. 197) because we used sagebrush-type habitats as indicated in SWReGAP mapping (https://swregap.org/) to estimate total acres of sagebrush per population's occupied habitat, while the RCP used landcover types from the Colorado Basinwide vegetation map and occupied habitat that included some non-habitat. We selected SWReGAP because it covers Colorado and Utah, whereas the Colorado Basinwide map only includes Colorado. We clipped sagebrush habitat types to the broader GUSG occupied and unoccupied polygons, removed human disturbance and conifer cover that was greater than 10 percent based on the Sage-Grouse Initiative's conifer mapping. For future versions of the SSA, we intend to update this metric with the quantity of seasonal (breeding to brood-rearing and summer) habitats within occupied range.

The final habitat factor that we assessed was habitat quality. To assess overall habitat quality, we referred to the optimal habitat structural guidelines developed for the RCP (2005, p. H-1). These metrics include percent canopy cover, canopy height, forb and grass cover, and seasonal habitat differences. Although we do not currently have specific habitat structure measurements for each population, there are multiple efforts underway. Instead, we used expert opinions of scientists (Expert Elicitation Meeting Notes 2018b; Brodhead 2019), and any available population-specific habitat data to evaluate the habitat quality for each population (West 2019; Holsinger 2019; Franklin 2019; Griffin 2019).

3.1.3 Condition Categories to Evaluate Population Resilience

Populations in a high (healthy) resiliency category are at lower risk from stochastic events, and more likely to persist over time. Populations in the high category have a large HMC growth rate, large population size, and many acres of sagebrush habitats that meet habitat guidelines for all seasons (Table 4, above). Conversely, populations in the low category are at a much greater risk from stochastic events and less likely to persist over time. Populations and/or categories scored in the critical category indicate there is high risk of extirpation or is already at a functionally extirpated level.

Table 5. Condition Category Table used to evaluate resiliency. The table outlines four categories of resilience for GUSG populations (high, moderate, low, and critical), with corresponding conditions for the demographic and habitat factors identified as individual and population needs. Categories are based on available metrics to assess overall resiliency of GUSG populations. For each metric, a population was given a score of 0-3, 0 being critical to 3 being high. The overall rank (final, black column) is an average of these scores, and each factor (demographic, habitat quantity, and habitat quality) has equal weight.

CONDITION CATEGORIES USED TO EVAULATE POPULATION RESILIENCE					
Resiliency Categories	**Demographic Factors**		**Habitat Quantity**	**Habitat Quality**	**Overall Score**
	HMC Growth Rate	**HMC Targets**	**Sagebrush (acres)**	**(Qualitative Evaluation)**	
High (healthy) 3	>0.5	At or above the target HMC	At or above the habitat quantity needed for target HMC	Meets most RCP habitat guidelines for sagebrush/shrub canopy cover and forb and grass cover for all seasons.	2.26–3.0
Moderate (moderately healthy) 2	-0.5 - 0.5	Within the low range of target HMC	Within the low range of habitat quantity needed for the target HMC	Meets some RCP habitat guidelines, sagebrush/shrub canopy or forb and grass cover can be limiting in most seasons.	1.6–2.25
Low (poor health) 1	-0.5 - -1	Less than the low target HMC	Less than the habitat quantity needed for low target HMC	Fails to meet most RCP habitat guidelines, with poor sagebrush/sage canopy cover and low grass and forb cover for all seasons.	0.76–1.5
Critical (functionally extirpated or close) 0	<-1.0	Single digits or less than half of the low target HMC	Less than half the habitat needed for the low target HMC	Severely below minimum RCP habitat guidelines, with little to no available sagebrush/shrub canopy cover, grass, and forbs dominated by nonnative plants. Affects all seasonal habitat.	0.0–0.75

3.2 Cause and Effects: Factors Influencing Viability

In this section, we describe both the positive (conservation efforts) and negative influences (stressors or threats) that affect GUSG individuals directly or indirectly by affecting the resources, they need to complete their life cycle. Stressors are the actions that negatively affect

the habitat and/or demographic factors that support population resiliency. Conservation actions are the activities or mechanisms that may act to help reduce a stressor or positively influence a habitat or demographic factor.

3.2.1 Population-Level Stressors

For our assessment of stressors that affect population resiliency, we relied on the available scientific literature and the draft results of the Gunnison Sage-Grouse Collaborative Action Plan (CAP) done by the Executive Oversight Committee for Conservation of Gunnison sage-grouse (EOCCGS) (EOCCGS 2018, p. 14). Since 1995, the local GUSG action groups began the grassroots efforts to address declines in GUSG populations. Over the years, local working groups and land management agencies (State and Federal) have continued to implement conservation actions to improve the conditions for GUSG. The CAP's intention is to address and prioritize current and future threats to GUSG range-wide by bringing together a broad coalition of partners (EOCCGS 2018, p. 5). The CAP team ranked factors that have no effect to a severe effect, incorporating the scope, severity, permanence, and immediacy of the threat on GUSG populations (see Appendix 6.3 for threat summary by population). For determining which factors negatively influence each population, we selected the highest magnitude issues from the draft CAP that are likely having an effect on a population. For the effects of each factor on individuals and the populations, we refer to the draft CAP and the 2014 listing decision (50 FR 69192).

Figure 9 below, illustrates the pathways of factors to how they negatively affect GUSG populations. These factors negatively affect all populations of GUSG; however, they act on different populations to different degrees. In seven of the eight populations (all except the Gunnison Population) that are affected by small population size and structure, the effects of other sources of stressors are exacerbated due to the small population size.

Following our description of factors, both negative and positive, we provide a summary of the greatest stressors by population in Section 3.4.

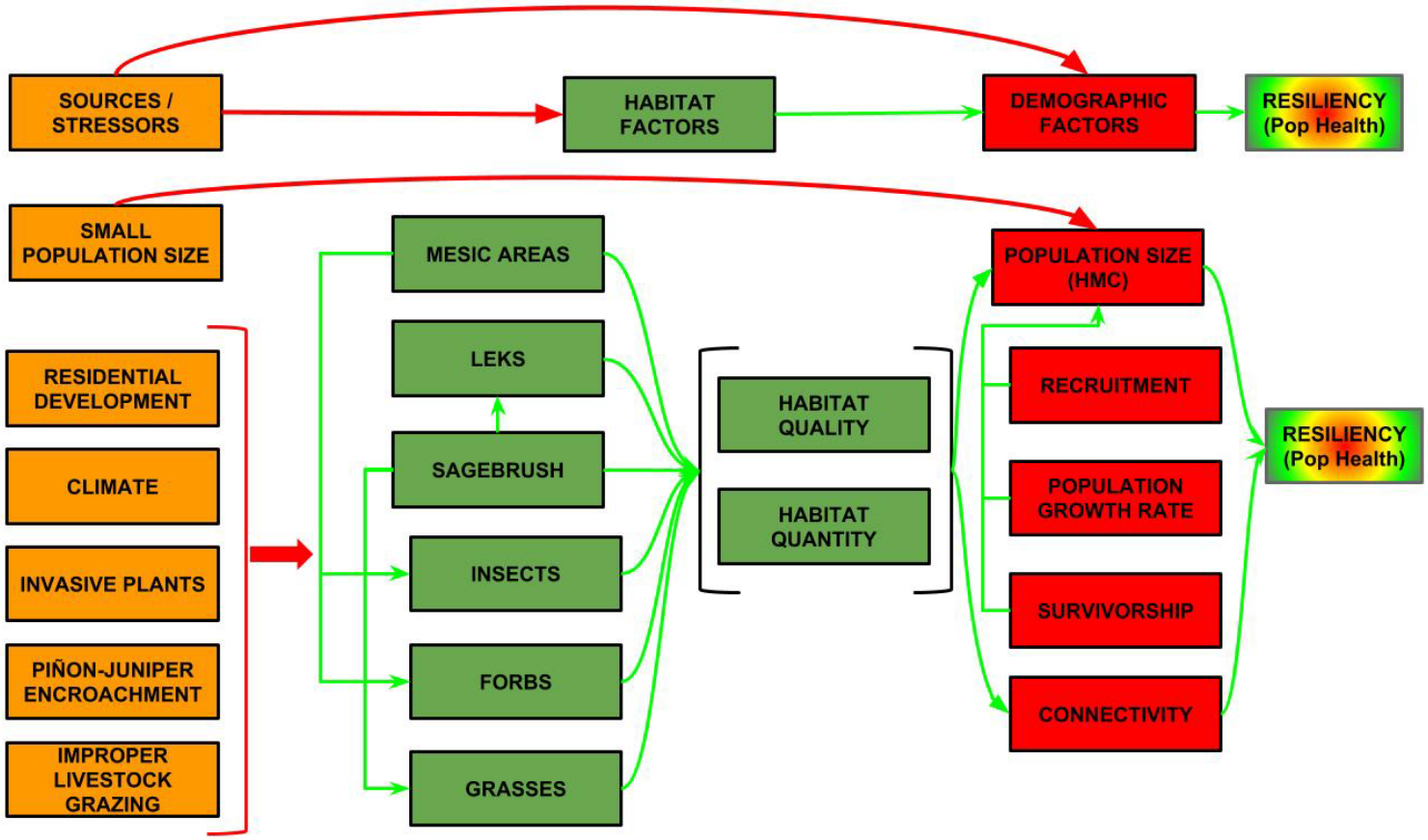


Figure 9. Model showing the relationship of the primary stressor sources to habitat and demographic factors. These ultimately affect population resiliency and species viability.

Small Population Size
Negative effects on population viability, such as reduced reproductive success or loss of genetic variation and diversity, become more evident as populations decline or become more isolated. When coupled with mortality stressors related to human activity, fluctuations in population size, and environmental factors, long-term persistence of small populations is generally unlikely (Traill *et al.* 2010, all). When a population size gets too small, where the number of breeding individuals does not maintain sufficient genetic diversity, the population is further at risk of inbreeding depression. Homozygosity can result in phenotypic expression of recessive and deleterious alleles (Charlesworth and Charlesworth 1987; Lynch *et al.* 1995), a reduction in the overall fitness of individuals in a population (Wright 1977), or both (Kimura and Ohta 1971). Loss of genetic variation reduces representation, as well as individual fitness and resilience to environmental stressors.

Residential Development
In their draft assessment, the CAP team ranked continued habitat loss to residential development as the greatest issue negatively affecting GUSG rangewide. Commercial and residential development causes the permanent modification of suitable habitat and creates an immediate loss to GUSG because the quantity of sagebrush habitat is limited. Therefore decreasing the carrying capacity of that habitat, and can occur in all habitat types including moderate to severe winter use areas, spring and summer (nesting and brood-rearing areas), and leks (GSRSC 2005, p. 161). This means a reduction of resources that provide for breeding, feeding, and sheltering, connectivity between habitat/populations, and therefore reduced population resiliency. Populations of GUSG that contain more privately owned lands are at greater risk of development due to fewer regulations.

The activities associated with residential/commercial development include the physical footprint of a structure/building, associated roads, and utilities, parking lots, and vehicle traffic as well as the degradation of the surrounding habitat from fences, human activities, altered water runoff patterns, and nonnative plants (GSRSC 2005, p. 146). Habitat degradation includes the reduction of habitat quality or characteristics on smaller scales, which creates patches of habitat.

Climate
Climate is a factor that can contribute both positive and negative effects to GUSG and their habitat. Climate scenarios that 1) occur or are likely to occur, and 2) negatively affect GUSG include cyclic drought and extreme weather events such as spring snows or hailstorms. Cyclical and recurring droughts reduce the soil moisture and availability of forbs for spring, summer, and early fall feeding resources. Recurring or long-term droughts can reduce survivorship and populations sizes as all life stages experience reduced from lack food resources. Severe spring snows or hailstorms could harm newly hatched chicks who are exceptionally vulnerable as well as adults. Hail could directly injure or cause mortality to individuals that would then reduce that year's recruitment and survivorship.

Invasive Plant Species
Invasive plants, plants not native to the GUSG ecosystem and causing a negative effect on GUSG habitat, alter the native plant community structure, composition, productivity, nutrient cycling, and hydrology (Vitousek 1990, p. 7)

Piñon-Juniper/Conifer Establishment in Sagebrush
Another source of habitat degradation is from piñon-juniper encroachment. Piñon pine and juniper have become more established in sagebrush-dominated lands in the last century (Commons *et al.* 1999, p. 238). This expansion is mostly attributed to fire suppression, domestic livestock grazing, shifts in climate, and increase in atmospheric carbon dioxide (Miller and Tausch 2001, p. 15). Commons *et al.* (1999, all) followed three leks in the Crawford population preceding and following piñon-juniper removal and saw more males on leks following the treatments. Studies have shown that GRSG avoid areas with piñon-juniper encroached during nesting and may reduce females survival and nest survival (Severson *et al.* 2017). Piñon-juniper encroachment into sagebrush habitats may also result in reduced lek activity (Baruch-Mordo *et al.* 2013, p. 238) and may negatively influence or reduce habitat use among breeding adults and nesting females, from research based on GRSG. Doherty *et al.* (2018, p. 9) suggests conifer canopy of as little as 0.8 percent at a 0.56 km² patch scale and 1.5 percent at a 4.0 km² landscape scale could reduce or eliminate lekking and nesting habitat for GUSG, based on parameters from GRSG research.

Improper Grazing Practices
Excessive grazing by domestic livestock during the late 1800s and early 1900s, along with severe drought, significantly affected sagebrush ecosystems. Over-utilization of the sagebrush environment for livestock grazing can and has historically reduced sagebrush, grass, and forb cover essential for GUSG survival (50 FR 62192, p. 69242). Effects of grazing on nesting habitats are dependent on the timing, duration, and intensity of grazing. Grazing on grasses and forbs during nesting and early brood rearing seasons could reduce food sources for young broods, potentially limiting recruitment in a population if occurring throughout summer habitat in a population.

3.2.2 Individual-Level Stressors, not carried forward in Analysis

The stressors described below negatively affect individual GUSG, however we do not know the full extent of their effect on individuals, or we do not believe it is causing a population-level response.

Predation
Predation is a cause of mortality of young age classes and adults on leks, on nests, and during winter (Young *et al.* 2015, 11). However, sage-grouse have co-evolved with a variety of predators and their cryptic plumage and behavioral adaptations have allowed them to persist despite this mortality factor (Schroeder *et al.* 1999, p. 10). Golden eagles (*Aquila chryaetos*) kill and may consume adult and young GUSG. Eggs and chicks are predated by common ravens (*Corvus corax*), red fox (*Vulpes vulpes*), ground squirrels (*Spermophilus* spp.), coyotes (*Canis latrans*), and weasels (*Mustela* spp.) (Young 1994, p. 37; Young *et al.* 2015, p. 11). Other causes of direct mortality or mortality from reduced fitness include human disturbance, farm machinery, moving vehicles, electric or telephone wires, fences, pesticides, fire, flood, drought, sun exposure, heavy rain, and cold weather (Rogers 1964; Young *et al.* 2015, p. 15).

Power Lines
New construction of large-scale power lines is not common presently. However, existing power lines and maintenance of existing power lines contribute to the degradation of GUSG habitat by facilitating the expansion of invasive plants, increasing predation by providing perches for raptors and corvids, and causing avoidance of the area by GUSG . Power lines can affect all habitat types GUSG use and cause direct mortality by collisions or electrocution, although that is rare. If power lines are near leks and/or nesting areas, it appears, lek attendance could be reduced as well as nest success (50 FR 69192, p. 69252).

Fire
Fires can cause the proliferation of invasive plant species and degrade GUSG habitat, which may take decades to recover to suitable condition or may not recover at all (50 FR 69192, p. 69253). Fires in the range of GUSG have been mostly small and there has been no obvious change in the fire cycle, so it was not considered a threat to GUSG in the listing decision. There is potential for fires to increase with drier temperatures and increased fuel loads from nonnative plant species in the future.

Noise Disturbance
An additional factor that causes negative affects to GUSG is noise disturbance. Noise levels 10 decibles (dBA) or more above ambient are caused by human activities such as operation of heavy machinery, vehicles, rumble strips on highways, and oil, and gas development etc. Noise at these levels can interfere with lekking, nesting, and brood-rearing activities by masking the sounds critical to GUSG communication and awareness of their environment (Blickley *et al.* 2012). Irregular and inconsistent noise during reproduction can be more detrimental than persistent elevated noise (Blickley *et al.* 2012). Elevated noise levels can interfere with males strutting on leks during breeding, resulting in lower reproductive potential. They can also interfere with the ability of hens to communicate with chicks.

Recreation
Nonconsumptive recreational activities can degrade wildlife resources, water, and the land by distributing refuse, disturbing and displacing wildlife, increasing animal mortality, and simplifying plant communities (Boyle and Samson 1985, pp. 110-112). Recreational use of off-highway vehicles (OHVs) is one of the fastest-growing outdoor activities. These activities can result in abandonment of lekking activities and nest sites by GUSG, energy expenditure reducing survival, and greater exposure to predators (GSRSC 2005). With human populations expected to increase in towns and cities within and adjacent to Gunnison Basin and nearby populations, the impacts to GUSG from recreational use will likely increase.

3.3 CONSERVATION EFFORTS

In this section, we focus on the actions that land managers have taken and are taking to directly reduce, limit, or avoid the factors described previously described. Prior to listing as Threatened under the ESA in 2014, various stakeholders implemented many actions with the intent of conservation and recovery of GUSG. These actions included both regulatory and restoration

measures to protect and improve the remaining habitat and prevent further decrease in GUSG numbers within the eight populations.

3.3.1 Long-Term Protection on Private Lands

Habitat preservation continues to be a major beneficial factor of focus for GUSG by various stakeholders and partners. Conservation easements (CEs) on private lands, in conjunction with the CCAA and county regulations have greatly helped prevent loss and degradation of habitat. At the time of listing, there were over 74,000 acres protected through CEs in occupied GUSG habitat, rangewide (79 FR 69192; Table 6). Land protected under a CE has strict limitations on future development and subdividing that benefits GUSG by protecting habitat indefinitely. As of 2018, the number of acres in occupied habitat (as mapped for Critical Habitat) has increased to 99,560 (data from Gunnison Legacy Trust).

3.3.2 Regulatory Measures on Private Lands

Most counties with GUSG populations have developed specific land use regulations addressing local habitat conservation in long-term development planning.

In coordination with private landowners, CPW, and the Service, 93,825 acres were enrolled in a Candidate Conservation Agreement with Assurances (CCAA) prior to listing of GUSG. The purpose of the CCAA was to encourage participating private landowners to implement conservation measures for GUSG, focusing on occupied and suitable habitat. The plan adopted grazing practice guidelines from the 2005 RCP to aid private landowners in managing their rangelands to benefit GUSG and cattle forage. There are 41 certificates of inclusion (CIs) for landowners enrolled in the CCAA, encompassing 93,825 acres. Approximately 81,156 of these CIs are in suitable habitat (CPW 2014a, entire; CPW 2014b, entire; CPW 2014g, Appendix 3).

3.3.3 Regulatory Measures on Public Lands

In 2013, Federal land management agencies, BLM- Gunnison FO, USFS- GMUG National Forest, NRCS, and NPS- Black Canyon of the Gunnison developed the CCA to address threats to GUSG habitat on federal public lands in the Gunnison Basin, especially from development, recreation, and grazing. This applies to approximately 395,000 federal acres of occupied habitat, nearly two-thirds of the total occupied acres in Gunnison Basin.

Following listing, BLM and USFS field offices amended existing plans to incorporate more GUSG protections and conservations measures under 7.a.1 of the ESA. The Black Canyon of the Gunnison National Park and Curecanti National Recreation Area also included conservation measures.

3.3.4 Habitat Restoration Actions

Piñon-juniper Removal
Research has demonstrated GRSG moved into sagebrush habitat containing the habitat conditions described in Chapter 2 after low levels of encroaching piñon-juniper were removed (Miller *et al.* 2005; Bates *et al.* 2017; Boyd *et al.* 2017; Miller *et al.* 2017).

Wet Meadow and Mesic Restoration
Wet meadow and mesic restoration projects have been shown to retain water on the landscape longer throughout the year, increasing forbs and grasses cover late into the summer for GUSG, livestock, and wildlife. These projects install rock structures in degraded drainages to manage surface water flow, restore vegetation, and re-establish natural hydrology. These projects have the potential to improve the diversity and resilience of wet meadow habitat types that are especially beneficial for spring and summer habitat. A subset group of the Gunnison Climate Working Group including members from BLM, BIO-Logic, Inc., Western State Colorado University, Upper Gunnison River Water Conservation District, The Nature Conservancy, NRCS, USFS, Colorado Natural Heritage Program (CNHP), CPW, Zeedyk Ecological Consulting, and Gunnison County have been cooperating since 2012 to increase wet meadow restoration in the Gunnison Basin and GUSG range.

3.3.5 Translocations and Captive Rearing

Overall, we expect that scientific research and related conservation efforts led by CPW, such as translocation and captive rearing of GUSG, have a net benefit for the species because they have helped to augment some of the satellite populations in terms of both population size and genetic diversity. Although we believe, translocations have had a net beneficial effect; potential risks associated with translocating GUSG include risk of mortality both from the process of moving birds and their behavioral response to being in new habitat. Results of GUSG captive-rearing efforts indicate captive-brood-rearing may not be viable, however, progeny from a captive-rearing program could be used to supply individuals for reintroductions (Apa and Weichman 2015, p. 74). If a captive flock was established and maintained there would be risks of reduced hatch rates and low genetic variation, and benefits would be the reduced cost compared to locating wild birds in the field (Apa and Weichman 2016, p. 11).

3.4 Evaluating Current Condition

Considering the stressors and conservation efforts currently influencing each population, we used our condition category table (Table 4, above) to evaluate the current condition for each demographic and habitat factor, for each population (Table 6). Each type of factor (demography, habitat quantity, and habitat quality) has equal weight. Then we calculated an overall score, which is the average score for demography (average of HMC growth rate and HMC 3-year average, compared to population target), then averaged with the habitat factors.

Table 6. Evaluation of current GUSG population resiliency, using the Condition Category Table (Table 4), which is based on the available metrics for demographic and habitat needs for each population. .

Population	Demography		Habitat Quantity	Habitat Quality	Overall Score
	HMC Growth Rate	HMC (3-year average)	Sagebrush (acres)	(Qualitative Evaluation)	
Gunnison Basin	2	772	426,218	High	3.00
San Miguel	0.04	47	57,854	Moderate	2.17
Piñon Mesa	-0.39	23	19,873	High	2.33
Crawford	-1.22	23	15,798	Moderate	1.17
CSCSM	-0.05	6	18,575	Moderate	1.67
Poncha Pass	-0.05	6	9,575	Moderate	1.00
Dove Creek	-1.48	0	12,294	Low	0.67
Monticello	-0.91	8	26,513	Low	1.17

Currently, Dove Creek is the only population in a critical condition (Table 6, Figure 12). Three populations are in low condition (Crawford, Poncha Pass, and Monticello), two populations are in moderate condition (CSCSM and San Miguel), and two populations are in high condition (Gunnison Basin and Piñon Mesa). Five of the populations have habitat in moderate quality, two populations have low habitat quality, and the Gunnison Basin and Piñon Mesa populations have habitat in high condition.

At the species level, the eight populations are distributed north to south in southwestern Colorado and east to west in southeastern Utah and southwestern Colorado (redundancy). The eight populations of GUSG occupy six different ecoregions, as described in Chapter 2. These are areas delineated by common geology, landforms, soils, vegetation, climate, land use, wildlife, and hydrology (EPA 2018). These ecoregions highlight unique ecological differences between the GUSG populations, which influence the condition of the habitat and demographic resources that are important to each population's resiliency. Additionally, these ecoregions indicate the ecological variation throughout the range of the species, and potentially the species adaptive capacity (representation).

Below, we discuss the evaluations for each population in more detail, including the stressors and conservation efforts that influence the condition for each population.

3.4.1 Gunnison Basin

The Gunnison Basin occurs in an ecoregion dominated by sagebrush and soils that contain more organic matter, thus nutrients, compared to other ecoregions in the range of GUSG. Gunnison Basin currently supports the largest population of GUSG with the highest genetic diversity, contains the most intact sagebrush habitat and overall habitat quality is the best. Overall, we consider the Gunnison Basin population to be highly resilient. The HMC growth rate is positive (2.0), the 3-year average (as of 2018) was above the HMC target, there is sufficient quantity of habitat to support the population, and the habitat available is of mostly high quality indicates high resiliency in the Gunnison Basin population. Additionally, Gunnison Basin contains the most mesic/riparian/wet meadow type habitat, which indicates greater quantity and quality of spring/summer habitat, especially important for chick and juvenile survival (Chapman *et al.* 2017, all).

The 23-year growth rate (1996-2018) for Gunnison Basin was 2.0, essentially meaning on average 2 males were added to the population per year. As indicated in Table 4, the Gunnison Basin population's 3-year average HMC was 772 (average of 2016, 2017, and 2018 counts), compared to the RCP target that we estimated as 612. Over time, this population has also been the most stable with HMCs consistently over 500. This indicates that this population has high resiliency, with population numbers able to rebound after environmental or stochastic events that may reduce population numbers, such as the drought during 2000-2004. The Gunnison Basin population has also maintained a steady male count, so much that CPW translocated 366 adult GUSG from this population into San Miguel, Crawford, Piñon Mesa, Poncha Pass, and Dove Creek populations (not in Monticello) from 2000-2014 (CPW 2014g, p. 11).

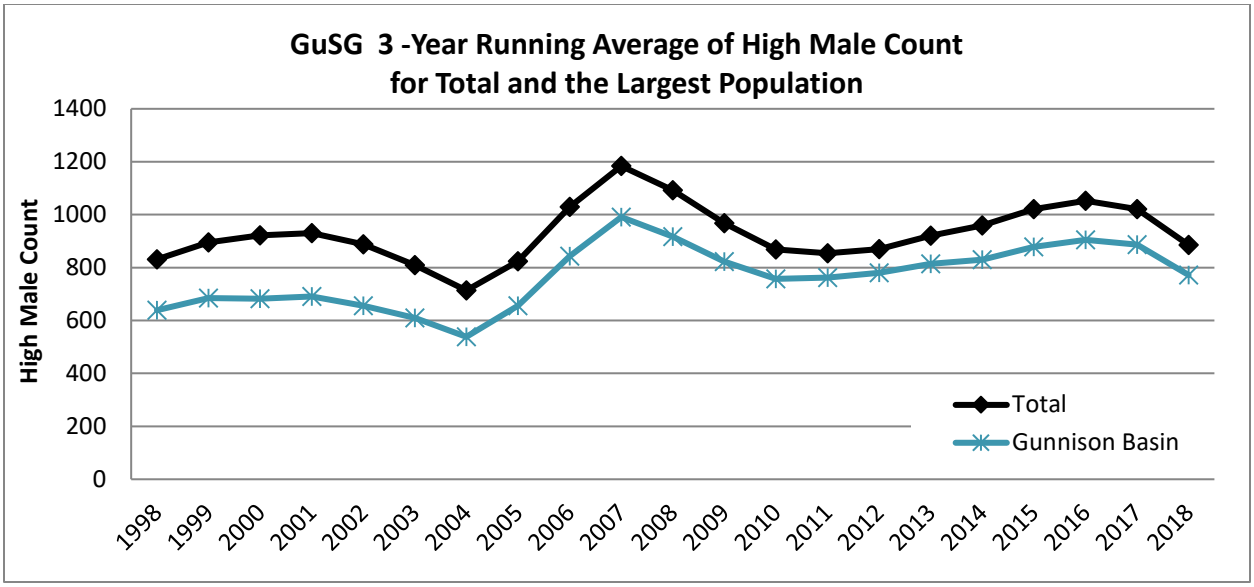


Figure 10. 3-year running average high male counts (HMCs) for the Gunnison Basin population and all populations combined. Data and figure provided by Colorado Parks and Wildlife (CPW), unpublished data

Gunnison Basin also contains sufficient quantity of sagebrush habitat such that our estimate exceeds the habitat quantity target. Overall habitat quality is good for all seasonal needs (Brodhead, pers. comm., 2019). Although sufficient habitat quantity is available and most of the habitat quality is within the RCP guidelines, our review indicated moderate levels of disturbance and some indicators of fragmentation might be negatively affecting the quality of the habitat now, and could into the future.

Greatest negative influences in the Gunnison Basin ranked by the CAP team (Draft) are severe drought and extreme weather, and residential development. These two issues were given a high magnitude rank. Stressors of moderate magnitude in the Gunnison Basin are invasive plants, recreation, roads, climate change, late seral stages of vegetation community, and loss of functionality or condition of mesic habitats.

23.3 percent of Gunnison Basin occupied habitat is privately owned and not under a conservation easement (50 FR 69192, p. 69234), so this land is potentially at risk of residential development, but subject to the County of Gunnison's land use regulations, which aim toward GUSG conservation and delisting. The threats assessment (draft) done for the Collaborative Action Plan (EOCCGS 2018) indicates severe drought and extreme weather, and residential development as the two factors with the greatest threat to GUSG in the Gunnison Basin. Moderate magnitude threats include invasive plants, recreation, roads, and loss of functional mesic habitat (EOCCGS 2018). BLM biologist, Kathy Brodhead also indicated BLM has been doing native seed planting to curb cheatgrass invasion (Brodhead personal communication, 2019).

Actions being done to minimize or avoid these negative influences include the Gunnison County Habitat Prioritization Tool (HPT). In 2011, Gunnison County established a tiered habitat ranking system for private land to assess and minimize effects of development on GUSG habitat (http://www.gunnisoncounty.org/DocumentCenter/View/3157). These measures allow for

modification or denial of building envelopes that would adversely affect GUSG and/or their habitat in Tier 1 habitat, through consultation with CPW and site-specific analyses (211). Proposed development in Tier 2 habitat may also require consultation with CPW biologists. County land use planning also may require mitigation if a project will have a significant net adverse impact (213). Gunnison County also places limitations on human activities during sensitive periods, like lekking, burial of utilities near leks, as well as controls on domestic dogs and cats. In 2018, CPW worked with Gunnison County and the Service to purchase land in Gunnison Basin around an active lek.

Multiple partners, including local GUSG working groups, BLM, Upper Gunnison Water Conservancy District, and Bio-Logic private consultants have completed over approximately 1,700 mesic and wet meadow restoration projects in the Gunnison Basin.

3.4.2 HMCs for "Satellite" Populations

The other populations show greater variation in HMCs, as shown in Figure 11 below. It appears that smaller population sizes (indicated by the HMC) are less capable of rebounding to stable sizes following stochastic events, such as drought, as visible in the decline 2000-2004. Other populations, however, appear to be holding numbers relatively stable even at very low HMCs including Cerro Summit-Cimarron-Sims Mesa, Poncha Pass, and Piñon Mesa. San Miguel and Monticello show high variation and significant decline.

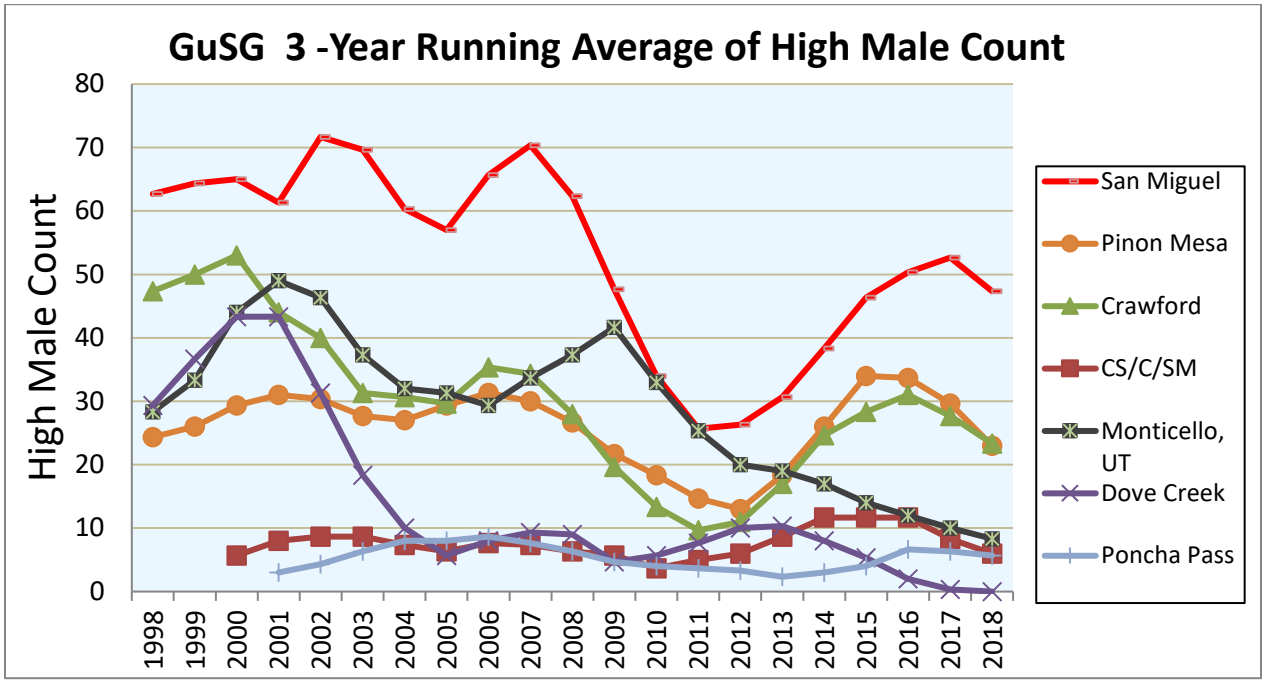


Figure 11. 3-year running average HMC for the smaller (satellite) populations of GUSG. Figure and data provided by CPW, unpublished data 2018.

We do not have range wide data for recruitment and survival; however, both of those demographic factors affect HMCs. Juvenile female GRSG in Colorado have higher survival rates than juvenile males, with lower male survival primarily occurring in September, perhaps

due to the higher nutritional demands of the larger male body (Apa *et al.* 2017, p. 663). Monthly juvenile survival represented from 31 days of age to the start of the first breeding season (April 1) was variable around 0.75 to 0.80 until September and remained at 1.00 from September to April (Davis 2012, p. 47). This is similar to survival patterns of adults and yearling GUSG; however, adult survival is much higher than chicks and juveniles. Male and female adult/yearling GUSG monthly survival stayed around 0.95 throughout the year, except in March when male survival dropped to around 0.80 and female survival dropped to around 0.90 in April (Davis 2012, p. 71).

Chick survival likely varies between populations, perhaps lower in the satellite populations as Davis (2012, pp. 35-37, 44) indicated much lower chick survival in San Miguel compared to Gunnison Basin. No monitored chicks in San Miguel survived to 30 days in the 4-year study, which could have been due to the small sample size (n=8) whereas the survival rate in Gunnison Basin was 0.468 (n=290). Although Gunnison Basin chicks did show higher recruitment and survival, trend was still declining over the course of the study (Davis 2012, p. 38). Davis (2012, p. 35) also found that survival increased with the age of a chick.

3.4.3 San Miguel

The San Miguel population is the second largest and occurs on the most diverse landscape. Six subpopulations in the San Miguel population occur in three different ecoregions. The subpopulations HMCs are summed for an overview of the whole population. Figure 11 shows a steep, decline in the total San Miguel HMC from 2008 to 2011. The overall HMC growth rate for San Miguel population for this period actually appears relatively steady at 0.04. However, the estimated low target HMC is 53 males and the current 3-year average was 47, indicating there is some risk in this population.

Our estimate of overall available sagebrush habitat was 57,854 acres, which is about 2,000 acres more than the estimated habitat needed to support the target HMC, indicating habitat quantity is not limiting in this population and could potentially support more individuals. Overall habitat quality is meeting some RCP habitat guidelines, which introduces risk from negative influences to further decrease habitat quality or act on the demographic factors or population size, recruitment, survival, growth rate, and connectivity.

Dry Creek Subpopulation
The Dry Creek Basin subpopulation of San Miguel is among the warmest and driest areas within the range of the species, it is also covers the largest occupied area of the San Miguel subpopulations. It has highly incised riparian drainages with little functional mesic habitat. The majority of the subpopulation occurs on BLM lands.

Average sagebrush height was 48.4 cm (19.05 in) which nears the “maximum” height guideline in the RCP. Herbaceous heights, percent of grass cover, and percent forb cover all decreased from 2015 to 2018. Grass cover and herbaceous heights have all remained within the RCP guidelines, however, forb cover dropped to 3 percent in 2017 (West personal communication, 2019). Low to moderate habitat quality affects the recruitment and survival, thus population size, particularly young age classes.

The highest-ranking threats to GUSG in the Dry Creek subpopulation are small population size and structure, severe drought and extreme weather, condition/availability of mesic habitat, and piñon-juniper encroachment. Secondary threats in Dry Creek include power/transmission lines, invasive plants, oil and gas development, late seral stages of vegetation, climate change, and roads (EOCCGS 2018).

From 2006 to 2014, the Dry Creek subpopulation received 62 total translocated birds from the Gunnison Basin (CPW 2014g, p. 11). There have been few rock structures placed to restore natural mesic/wet meadow areas (Grant 2018); however, their functionality is limited in low precipitation years.

Hamilton Mesa Subpopulation
The greatest threat acting on the Hamilton Mesa subpopulation is small population size/structure. Less immediate threats include climate change, late seral stages of vegetation, severe drought and extreme weather, and catastrophic fire events (EOCCGS 2018). Hamilton Mesa is 85 percent private ownership and provides summer habitat for GUSG (GSRSC 2005, p. 96).

Miramonte Reservoir Subpopulation
The greatest stressors acting on the Miramonte Reservoir subpopulation are small population size and structure, severe drought/extreme weather, and piñon-juniper encroachment. Stressors moderately affecting the subpopulation are climate change and the condition/availability of mesic habitat. There is some, low-level risk from catastrophic fire events and residential development (EOCCGS 2018).

In 2013 and 2014, 23 birds were translocated into Miramonte (CPW 2014g, p. 11). In 2018 CPW also expanded the Dan Noble wildlife management area within the Miramonte Reservoir subpopulation with 500 acres of land donated for mitigation of a transmission line in Dry Creek Basin (Griffin 2019). Also in 2018, 34 small rock structures were placed in the Miramonte subpopulation occupied range on private lands and 11 were built on San Miguel County lands (Grant 2018). We currently do not have how many acres of wet meadow were restored from these structures.

Gurley Reservoir Subpopulations
The two greatest stressors affecting GUSG in Gurley Reservoir are small population size/structure and residential development. Moderate threats are climate change and severe drought/extreme weather (EOCCGS 2018).

Beaver Mesa Subpopulation
Beaver Mesa subpopulation is primarily affected by small population size/structure and piñon-juniper encroachment (EOCCGS 2018). Moderate-level threats are climate change and severe drought/extreme weather.

Iron Springs Subpopulation
Greatest threats in Iron Springs are small population size and structure, residential development, and piñon-juniper encroachment (EOCCGS 2018). Moderate threats are climate change, severe drought/extreme weather, and the condition/availability of mesic habitat (EOCCGS 2018).

3.4.4 Piñon Mesa

The Piñon Mesa population is in the northwestern-most range of GUSG, in Mesa County. From 1996 to 2018 the HMC growth rate was -0.39 and the most current HMC 3-year average was 23. A HMC of 23 is the lowest target HMC from the RCP population targets (GSRSC 2005, p. 2). We calculated 19,873 acres of sagebrush habitat, which is only about 500 acres more than the low target habitat quantity. However, habitat quality in the occupied areas is high, meeting most RCP guidelines (Neubaum 2019).

Greatest threats in Piñon Mesa are small population size/structure, severe drought/extreme weather, and residential development (EOCCGS 2018). Moderate level threats include catastrophic fire events, climate change, and invasive plants (EOCCGS 2018).

Between 2010 and 2013, 93 birds were translocated into Piñon Mesa (CPW 2014g, p. 11). In Piñon Mesa, on Timber Ridge, GUSG now occupy an area that was subject to an extensive piñon-juniper removal project in the early 2000's (Neubaum 2019). In 2018, Western Colorado Conservation Corps (WCCC) in partnership with the wet meadow restoration group completed 22 rock structures on BLM land in unoccupied GUSG habitat. Although this area is not currently used by GUSG, restoration projects like this may help improve habitat quality and quantity of occupied range.

3.4.5 Crawford

Crawford HMC has declined rapidly over the 23 years of standardized lek counts, with a HMC growth rate of -1.22. The current 3-year average HMC is 23, which is below the low target HMC of 32.

Crawford occupied habitat is primarily on BLM land on Fruitland Mesa, and bordered to the west and south by Gunnison Gorge National Conservation area and Black Canyon of the Gunnison National Park, respectively. These areas limit suitable habitat outside of the currently occupied area due to the topography, while agricultural areas surrounding the town of Crawford limit potential habitat to the north and east. Overall habitat quality is moderate because sagebrush cover is lower than the RCP guidelines (Holsinger 2019) due to year-round grazing pressures from cattle, sheep, and wild ungulates. Low sagebrush cover likely contributes to predation pressure and exposure of young chicks. Summer habitat does not seem to be limiting, but could be improved.

The greatest threats affecting GUSG in Crawford are small population size and structure, condition/availability of mesic habitat, improper domestic sheep grazing, piñon-juniper encroachment, severe drought/extreme weather, and to some degree residential development.

Moderate-level threats include recreation, roads, invasive plants, climate change, and late seral stages of vegetation (EOCCGS 2018). From 2011 to 2013, 72 birds were translocated from Gunnison Basin into the Crawford population (CPW 2014g, p. 11).

3.4.6 Cerro Summit-Cimarron-Sims Mesa

Two subpopulations, Cerro Summit-Cimarron and Sims Mesa, make up the CSCSM population. We consider them two subpopulations because they are geographically separated. GUSG movement between the two areas is unknown (GSRSC 2005, p. 56). HMCs for this population have remained stable, although very low in the single digits.

Cerro Summit-Cimarron-Sims Mesa also has distinct differences in mesic habitat availability. The Cerro Summit-Cimarron portion appears to have moderate moisture and temperature near the known active lek that can sustain mesic habitat. Outside of this area, there is not much potential for new mesic habitat restoration in this population. Sims Mesa sub-population is significantly drier and has low potential for further mesic habitat restoration in the unoccupied sagebrush habitat on the mesa top. Most mesic habitat within the occupied habitat is in the surrounding lowland irrigated lands. CSCSM is also primarily privately owned and along the highway 50 corridor.

The greatest threats to the Cerro Summit-Cimarron subpopulation are small population size and structure, residential development, roads, severe drought/extreme weather, and piñon-juniper encroachment (EOCCGS 2018). On a moderate level, recreation, power lines/transmission lines, climate change, and late seral stages of vegetation are also acting on this subpopulation (EOCCGS 2018). No birds have been translocated into the Cerro Summit-Cimarron subpopulation.

In Sims Mesa, the greatest threats affecting GUSG are small population size and structure, residential development, roads, condition/availability of mesic habitat, recreation, improper cattle grazing, invasive plants, piñon-juniper encroachment and severe drought/extreme weather.. Moderate level threats include late seral stages of vegetation, climate change, and catastrophic fire events (EOCCGS 2018). In 2000, 6 birds were brought into Sims Mesa (CPW 2014g, p. 11).

3.4.7 Poncha Pass

Poncha Pass is the only population east of the Gunnison Basin. This population was reestablished in the 1970s after it was assumed extirpated in the 1950s. Reestablishment began with 30 birds translocated from the Gunnison Basin (GSRSC 2005, p. 94). HMCs have been low and relatively stable since counts started here in 1999. All of the birds that make up the Poncha Pass population were translocated from the Gunnison Basin. The low target HMC is 9, and the most recent 3-year average count is 6.

Our estimate of available sagebrush habitat in Poncha Pass occupied range is 9,575 acres. This does not likely allow for much expansion of the GUSG population. The habitat quality is considered moderate, because Highway 285 and a transmission line to the west interrupt habitat. Overall, the sagebrush, forb, and grass cover are good, however translocated and radio-collared

birds have moved into the west area only temporarily and only occupy the east side of the highway (Griffin 2019). Due to the high elevation, nonnative plant species are less likely to invade at unmanageable rates.

Greatest threats in Poncha Pass are small population size/structure, severe drought/extreme weather, and loss of functionality or condition of mesic habitat (EOCCGS 2018). Moderate level threats include recreation, power lines/transmission lines, residential development, climate change, invasive plants, roads, fences, late seral stages of vegetation community, mining of locatable (uranium, gold) and salable (gravel) (EOCCGS 2018).

More recently, birds were translocated into Poncha Pass on two occasions. The first, in 2000 and 2001 brought 41 birds from Gunnison Basin, and then following a HMC of zero in 2013, another 27 birds were translocated in 2013 and 2014 (CPW 2014g, p. 11).

3.4.8 Dove Creek

There has been serious decline over the 23 years of standardized lek counts in Dove Creek. In 2000 and 2001 3-year averages for the HMC were 43, HMCs for 2017 and 2018 were zero. This dwindling population has low amounts of occupied and available habitat and approximately 87 percent of occupied habitat is privately owned, increasing the risk of development and habitat loss. The Dove Creek-Monticello population is predominately warm and dry, with low amounts of natural mesic habitat.

High magnitude threats affecting the Dove Creek population include small population size/structure, condition/availability of mesic habitat, severe drought/extreme weather, residential development, other leasable minerals, changes to CRP funding, practices and enrollment, piñon-juniper encroachment, and oil and gas development. Moderate threats include invasive plants, conversion to agriculture, climate change, and roads (EOCCGS 2018).

In 2010 and 2011, 42 birds were translocated into Dove Creek from Gunnison Basin (CPW 2014g, p. 11). Dolores County regulations may consider wildlife habitat impacts in any project (http://www.dolorescounty.org/documents/#lda?option=lda). They may require a project proponent to implement CPW recommendations before approving a permit. Dolores County re-routes truck traffic during GUSG breeding season to avoid disturbing a lek in close proximity to a road (Dolores County 2018). A few wet meadow restoration structures were placed in a drainage area, however is not yet effective due to lack of precipitation. From 2013-2015, 5,608 acres in Dolores County (and some in San Miguel County) were placed under conservation easements. Current conditions of Crop Rotation Program (CRP) lands in occupied GUSG range are poor because of very dry conditions (Dolores County 2018).

3.4.9 Monticello

Monticello received an overall health rank of low. The HMC growth rate was very low, -0.91 and the 3-year average HMC was 8. Although quantity of sagebrush habitat exists to potentially

support up to the low target HMC, overall habitat quality is poor. Very dry conditions contribute to low habitat quality

Threats in the Monticello population include condition/availability of mesic habitat, renewable energy development (wind), small population size and structure, severe drought/extreme weather, conversion of habitat to agriculture, changes to CRP funding, practices, and enrollment, invasive plants, and piñon-juniper encroachment (EOCCGS 2018). Moderate level threats include power lines/transmission lines, roads, and climate change. No birds have been translocated into Monticello.

3.5 CURRENT CONDITION: REDUNDANCY

Redundancy describes the number and distribution of the populations and is the ability of a species to withstand catastrophic events. Species with a greater number of populations that are more widely distributed are generally at lower risk to catastrophic events than species with fewer populations that are closely distributed.

GUSG currently has seven populations in southwestern Colorado and one population in Utah (Figure 12, below). The eight populations provide redundancy that reduces risk from catastrophic events. However, the eight populations are distributed relatively narrowly in southwestern Colorado and a small corner of Utah, which put the species at greater risk to catastrophic events than if it were more broadly distributed. Additionally, the Gunnison Basin and Piñon Mesa populations are the only populations in the high resiliency category and Gunnison Basin provides the majority of the adaptive capacity of the species because Piñon Mesa's high health has been reliant on translocated GUSG individuals into the population.

3.6 CURRENT CONDITION: REPRESENTATION

Representation describes the ability of a species to adapt to changing environmental conditions. The eight populations of GUSG occupy a diversity of environmental conditions, ranging from cold and dry (Gunnison Basin) to warmer and wetter (Piñon Mesa) as well as hot and dry (Dry Creek Basin in San Miguel) and six different ecoregions. The conditions in other populations fall on a gradient between these conditions. Populations also differ in the composition of sagebrush species, topography, and soils Although this seems to indicate the GUSG has some adaptability to ecological variation, the majority (about 85 percent) of the species occurs in Gunnison Basin where temperatures are cooler, there is more precipitation, more sagebrush, and better forb and grass cover. These environmental differences between the populations help spread risk associated with potential catastrophes, such as widespread drought, and help reduce risk associated with novel, environmental change, such as long-term climatic changes.

There is low genetic diversity in GUSG compared to GRSG (Oyler-McCance *et al.* 2005, p. 630) which is likely influenced by the lack of connectivity between populations. A genetic study of the allelic differences between populations revealed lower levels of genetic diversity in six smaller populations (not including CSCSM) compared to the Gunnison Basin prior to any translocations (Oyler-McCance *et al.* 2005, p. 635). Collectively, the smaller populations (San

Miguel, Monticello-Dove Creek, Piñon Mesa, and Crawford) contain 24 percent of the genetic diversity of the species while representing only about 14 percent of the entire population size. Cerro Summit-Cimarron-Sims Mesa population was not analyzed in this study and Poncha Pass has no unique genomes, following local extirpation and reestablishment of the current population through translocations from Gunnison Basin.

Within the entire range, genetic heterogeneity is highest in the Gunnison Basin population and lowest in Piñon Mesa, which is the most geographically isolated from Gunnison Basin. Low genetic diversity puts an entire population at greater risk from new environmental and demographic stresses (GSRSC 2005, p. 113), such as potential mortality from disease and low hatching success resulting from inbreeding (Stiver *et al.* 2008, p. 479). Even the largest of the satellite populations, San Miguel, is likely experiencing an inbreeding depression. The population as a whole has moderate HMC growth and HMCs are less than, but near, the target HMC. However, the subpopulations are spread out across the San Miguel Basin and individually, may not be moderately healthy.

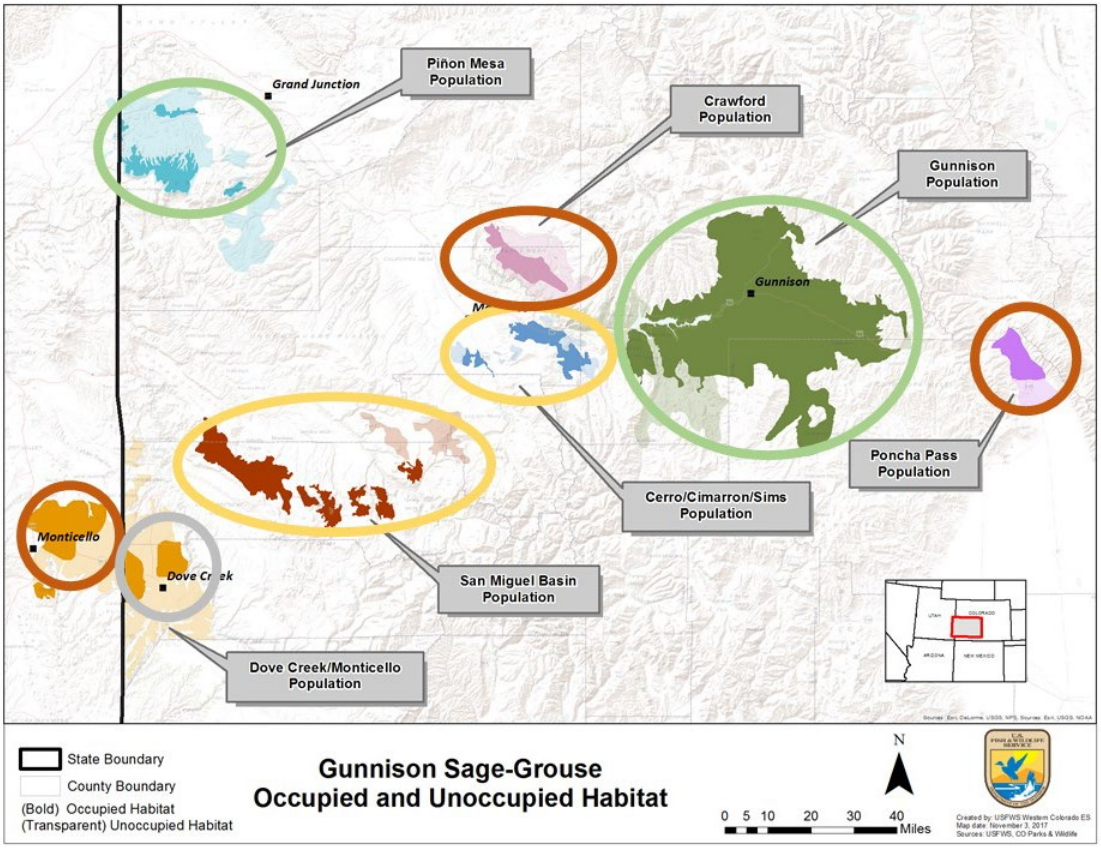
In addition to the low resiliency of the satellite populations, connectivity between all populations is limited. Distances between populations ranges from less than 11 km (7 mi) to over 100 km (60 mi). Some telemetered birds made seasonal migrations of 14 km (9 mi), while the majority of birds return to the same breeding and nesting areas each year and stay within a 5 km (3 mi) area (Commons 1997, p. iii). Oyler-McCance *et al.* (2005, p. 636) identified three possible dispersers (birds moving between populations) based on genetics. Two probable dispersers were individuals moving from San Miguel into Dove Creek/Monticello and Crawford, distances range 30-100 km (18-60 mi) and 60-100 km (37-60 mi) respectively. The other disperser involved movement into Crawford from Curecanti (western edge of Gunnison population) approximately 50 km (31 mi) (Oyler-McCance *et al.* 2005, p. 636). The long distance between populations reduces the likelihood of GUSG to migrate between them, resulting in decreased genetic diversity and a lower fitness. We have very little evidence of how birds currently move between populations, and it is very unlikely that birds would repopulate an extirpated area on their own due to low population numbers. However, the successful translocations that occurred in 2006-2014, the increase in HMCs following translocations, and successful breeding with the local population indicates translocating is an effective way to supplement populations. With a focused effort on the populations that are most likely to continue to support the demographic and habitat needs of GUSG, translocations are a recovery action that could increase the redundancy of GUSG. We investigate the potential effects of ongoing, additional, and reduced translocations to population resiliency under the Future Conditions chapter.

Recent genetics work found that birds translocated from the Gunnison Basin to the other populations successfully bred with resident birds (Zimmerman *et al.* 2019), indicating that translocated birds survived and increased the diversity of the host populations. However, it is unclear if the remaining genetic differences between populations confer some type of adaptive advantage, such as those tailored to population's specific habitat type. It is possible that some of the genetic differences between GUSG satellite populations could represent adaptation to the different environmental conditions found across the current distribution. This would include variation in the dominant sagebrush species and micro-climates. Possible genetic adaptations to local environmental conditions, such as the digestibility of local sagebrush species, needs further

investigation (Kohl *et al.* 2015, p. 432). Many of the genomic differences have also been altered from translocations from Gunnison Basin. Although this means the unique genes of the satellite populations could be lost, it also makes the satellite populations more genetically diverse and more likely to avoid inbreeding depression.

3.7 SUMMARY OF CURRENT CONDITION

Currently, Dove Creek is the only population in a critical condition (Table 6, Figure 12). Three populations are in low condition (Crawford, Poncha Pass, and Monticello), two populations are in moderate condition (CSCSM and San Miguel), and two populations are in high condition (Gunnison Basin and Piñon Mesa). Five of the populations have habitat in moderate quality, two populations have low habitat quality, and the Gunnison Basin and Piñon Mesa populations have habitat in high condition. Populations in higher resiliency categories are at less risk from potential stochastic events, such as extreme weather events, than populations in lower resiliency



categories.

Figure 12. This map indicates the eight populations of GUSG and each population is circled by the color indicating overall population condition. Gunnison Basin and Piñon Mesa are circled in green for high health condition, San Miguel Basin and CSCSM are circled in yellow for moderate health condition, Poncha Pass, Crawford, and Monticello are circled in red indicating low health, and Dove Creek is circled in gray for critical health condition.

At the species level, the eight populations are distributed north to south in southwestern Colorado and east to west in southeastern Utah and southwestern Colorado (redundancy). In general, the eight populations occur in similar habitats, although in six ecoregions with differences between them, such as elevation differences (representation). The eight populations reduce risk associated with potential catastrophic events, such as drought. However, only two of the eight populations are in the high resiliency category. Furthermore, the relatively narrow distribution of the eight populations across the southwestern corner of Colorado and southeastern Utah increases risk from a catastrophe.

Gunnison Basin population is in high condition that has not received additional GUSG individuals through translocations. The high health condition is driven largely by its consistently large population size and sufficient quantity of sagebrush habitat. Piñon Mesa also came out as having high health due to the quality of habitat, and moderate health of the HMC demographic factors. The next two largest populations, San Miguel (moderate condition) and Crawford (low condition), have all fluctuated in HMCs during the same period but have generally increased since 2011 to 2012. These populations also received translocated birds from the Gunnison Basin. Poncha Pass (low condition) had a HMC of zero in 2013, and received 27 translocated birds from Gunnison Basin in 2013 and 2014. CSCSM is in low condition, with consistently low population numbers, yet persists without translocations or other significant population management actions. All the other smaller populations are at higher risk because of their low numbers and poor habitat conditions.

Analysis of microsatellite and mtDNA sequence data has found some evidence of movements among populations, yet substantial genetic structure exists among populations, indicating that gene flow is low and movements among populations are rare (Oyler-McCance *et al.* 2005, p. 635). For populations of GUSG with low connectivity to other populations, we will continue to see the high levels of genetic differentiation between populations, which, in small populations, ultimately reduces their genetic fitness. The Cerro Summit-Cimarron-Sims Mesa population may provide an important "stepping-stone" that links the larger populations of Gunnison and San Miguel (GSRSC 2005, p. 51).

Therefore, the overall viability of the species is essentially reliant on the resiliency of the Gunnison Basin population. As the only population in a high resiliency condition that has self-sustaining recruitment, the Gunnison Basin population is the best able to withstand stochastic events, so it is critical to the viability of the species. Piñon Mesa is in a high condition as well, although it is at the lower level and reliant on conservation efforts. The remaining populations are currently in moderate, low, or critical condition, so they are at greater risk from stochastic events. Additionally, due to the limited quantity of habitat and low connectivity between populations, this species is reliant on relocation efforts to maintain resiliency. Translocation efforts have been important to ensure that some of the eight populations are resilient currently, and these efforts will likely need to continue in the future to maintain genetic diversity (Zimmerman *et al.* 2019, p. 8).

The primary concern for the recovery and persistence of the species is to maintain multiple highly resilient populations in addition to the Gunnison Basin population. The moderate to

critical levels of resiliency in all other populations make them at greater risk and reduce their contribution to the redundancy of the species.

4 SPECIES FUTURE CONDITIONS

In this chapter, we forecast the resiliency of GUSG populations, and the redundancy and representation of the species, over the next 15 and 30 years (to 2035 and 2050) using several plausible, future scenarios. We selected scenarios to 2035 and 2050 because this is the range of available, localized climate models, predictions about human population growth, response of sagebrush ecosystem to those changes, and is biologically relevant to GUSG. Three future climate predictions developed for southwestern Colorado were used to develop three future scenarios to evaluate the condition of the species. These scenarios are continuation, optimistic, and pessimistic scenarios. We also developed three conservation scenarios to explore the potential impact of conservation on the species' future condition. With these scenarios, our evaluation of future condition presents a plausible range of expected species responses (health) into the future, using the results of our Current Conditions (Chapter 3) as the baseline.

The viability of GUSG depends on maintaining multiple self-sustaining populations within the existing range, with suitable quantity and quality of habitat, into the future. Given GUSG's dependency on the sagebrush ecosystem and seasonal habitat resources for all life stages, the preservation of existing sagebrush habitat is essential to support the future resiliency of all populations. Climate factors such as temperature and precipitation can affect the success of preservation and restoration in GUSG habitat as well as the maintenance of existing sagebrush systems. In the absence of available habitat and connectivity between populations, small, isolated populations need continued translocations to avoid the effects of genetic drift.

4.1 ENVIRONMENTAL AND CLIMATE PREDICTIONS

We selected three plausible future climate models for the range of the GUSG over the next 15 to 30 years. The climate models developed for this area are Feast and Famine (further referred to as Moderately Hot), Warm and Wet, and Hot and Dry summarized in Tables 7 and 8, the following climate model descriptions are adapted from Rondeau *et al.* (2017, Appendix D 64-67). Ecological response models descriptions are adapted from Rondeau *et al.* (2017, 17-22)

Moderately Hot
In the Moderately Hot (Feast and Famine) scenario, average annual temperature will increase 3°F by 2035 and 5°F by 2050. Average annual precipitation does not change by 2035; however, by 2050 annual precipitation will decrease by 3 percent. We will experience larger year-to-year fluctuations in precipitation, with some very wet years and some intense drought years, as compared to our current climate. Winter precipitation will increase, but precipitation will decline in the other seasons. When droughts occur, they will be more intense than present but generally last less than two years. Once every decade we will experience a drought similar to the 2002 and 2012 droughts (years when precipitation was 40 percent below average). By 2050, we

will experience droughts similar to the 2002 and 2012 droughts every 5 years. The growing season will expand by two weeks, and during wet years, vegetation growth will be exceptional with trees, shrubs, and ground cover greatly increasing. The frequency of severe El Niño and La Niña events will double to an average of once every seven years. In the recent past, severe El Niño events in this region occurred in 1982, 1983, 1997, and 1998, with annual precipitation at roughly 20 percent above average. Invasive species will do well under El Niño conditions but decline in La Niña conditions (drought years). In El Niño and "Feast" years, trees, shrubs, and ground cover will do well with an expanded growing season.

The annual fire risk is lower in this scenario than the Hot and Dry scenario. Large fluctuations between wet and dry years will increase fuel growth during wet years. Year to year, summer monsoons will be more variable than they are currently. Intense droughts will more frequently follow extreme wet years. Multi-year droughts are less likely in this scenario compared to the Hot and Dry scenario. Increased evapotranspiration, driven by higher temperatures, will reduce soil moisture.

Seeps, springs, and other groundwater dependent wetlands will experience a moderate decline, especially below 8,500 ft., where spring precipitation will fall as rain instead of snow. Species that can tolerate drier soil conditions, including sagebrush, shrubby cinquefoil, and rabbitbrush will flourish, as will invasive species such as cheatgrass and knapweed. Juniper establishment in sagebrush is likely during the wet years following a drought year. Overall, sagebrush cover will likely be maintained, however in dry years, understory native grasses and forbs will be sparse. Without intervention, invasive species will expand.

Warm and Wet

In the Warm and Wet scenario, annual temperature increases by 2°F by 2035 and 4°F by 2050. Under this scenario, summer temperatures will last a week longer; annual precipitation will increase by 10 percent by 2035 and 8 percent by 2050 (in terms of soil moisture and stream flows, a 5 percent increase in precipitation is needed to offset the 2°F increase in temperature with its associated higher rate of evapotranspiration). Drought years, such as 2002, will occur every 15th year, similar to today's frequency. However, the intensity and severity of droughts will increase because of higher temperatures. While the water stress from 2°F-temperature increase will be offset by a 10 percent increase in precipitation, ecosystems will change in measurable ways. For example, the ratio of warm season to cool season grasses will change, and we could see declines in western wheatgrass and needle and thread grass, while blue gramma and galleta grass expand. The snowline will shift upwards by 600 ft. In this scenario, heat waves similar to 2002 (5°F above normal) will occur once every decade. The fire risk in this scenario is the lowest of any scenario, but fires will be present, and intermittent dry conditions may cause severe fire hazards because of high fuel loads. A 2°F increase in temperature will increase the fire frequency up to four times and the annual area burned by six times. In this scenario, there will be greater than normal winter snowpack above 10,000 ft, and spring, summer, and fall precipitation will increase at all elevations. The increase in year-round moisture coupled with a moderate increase in temperature will promote invasive species (more so than any other scenario). Current invasive species present in the southwestern Colorado such as leafy spurge, knapweed, cheatgrass, yellow toadflax will expand into low to montane elevations and new invasive species such as Japanese brome or purple loosestrife will likely move into higher

elevations area. Further, invasive species will out-compete the native vegetation, degrading rangelands.

Seeps, springs, and other groundwater dependent wetlands will increase or experience very little change. Higher soil moisture will likely eliminate or reduce invasive species in wetlands. There is uncertainty about how more snow could affect winter sage grouse habitat. It is possible some areas could see sagebrush mortality due to higher winter moisture.

Hot and Dry

In the Hot and Dry scenario, annual temperature increases approximately 5°F by 2035 and 7°F by 2050. Under this scenario, by 2035, every summer will be warmer than 2002 and 2012, two years when we experienced excessive heat waves. At elevations below 7,000 ft, for at least two weeks during the summer, nighttime lows will not dip below 68°F, and summer temperatures will last a month longer. Annual precipitation will decline by 10 percent by 2035 and decline by 14 percent by 2050, and the combined effect of warming and lower precipitation will result in nearly 45 percent decrease in annual runoff. There will be large increase in the frequency of extreme drought years such that every fifth year by 2035 and third year by 2050 we will experience droughts similar to 2002 and 2012 (when precipitation was 40 percent below average). Spring snowpack will decline by 10 percent and spring temperatures will increase by 4°F.

This combination of a reduced snowpack and warmer spring temperatures will reduce the available water during the growing season. Trees and shrubs (especially sagebrush) rely on winter and spring snows and snowpack for soils to remain moist during the growing season. Therefore, reduced snowpack associated with warmer and drier springs will negatively affect vegetation with deep roots. Summer precipitation will decrease by 20 percent and have a large detrimental effect on vegetation, especially shallow rooted plants, such as grasses and forbs. Seeps, springs, and mesic meadows will likely become dominated by shrubs and aspen stands will decline. Snowline shifts up by 1200 ft. and could influence (likely reduce) soil moisture in the lower elevations. In addition, the average timing of snowmelt will shift a full three weeks earlier from temperature increase and more frequent dust-on-snow events (which will occur every year).

If fires occur in sagebrush, it will likely convert to rabbitbrush and/or grassland rather than back to sagebrush for lack of soil moisture. Sagebrush requires at least 7.5 in of annual precipitation and water stress will make it difficult for low elevation sagebrush to regenerate.

Table 7. Summary of climate predictions out to 2035.

2035 Title	Continuation	Scenario 1	Scenario 2
Climate	Moderately Hot (Feast and Famine)	Warm and Wet	Hot and Dry
Annual temperature increase (°F)	2.9	>2	5
Winter temperature increase (°F)	3.3	3.5	4.1
Spring temperature increase (°F)	2.2	2.3	3.8
Summer temperature increase °F)	3.4	2.8	6
Fall temperature increase (°F)	2.9	2.1	5.3
Annual precipitation (%)	no change but large year to year variation	Increase 10%	Decrease 10%
Winter precipitation (%)	6	13	19
Spring precipitation (%)	0	6	-9
Summer precipitation (%)	3	8	-19
Fall precipitation (%)	-9	10	-15
Freezing level	shifts up by 900 ft	shifts up by 600 ft	shifts up by 1200 ft
Runoff	10% decrease	stays the same as baseline	>20% decrease
Timing of peak runoff	earlier by 2 weeks	earlier by 1 week	earlier by 3 weeks
summer monsoon	large year to year fluctuation	increase by 10%	decrease by 20%
Summer like 2002	every 3 years	every 10 years	every summer
Severe drought duration	1-2 years	1 year	1-5 years
2002/2012 Drought	every 10th year	every 15th year	every 5th year
Strong El Nino return frequency	doubles	no change	no change

Table 7. Summary of climate predictions out to 2050.

2050 Title	Continuation	Scenario 1	Scenario 2
Climate	Moderately Hot (Feast and Famine)	Warm and Wet	Hot and Dry
Annual temperature increase (°F)	5	4	7
Winter temperature increase (°F)	5	5	6
Spring temperature increase (°F)	4	3	6
Summer temperature increase (°F)	5	4	8
Fall temperature increase (°F)	5	3	7
Annual precipitation (%)	Decrease 3%	Increase 8%	Decrease 10%
Winter precipitation (%)	-3	14	15
Spring precipitation (%)	-9	6	-20
Summer precipitation (%)	7	9	-17
Fall precipitation (%)	-7	6	-16
Freezing level	shifts up by 1500 ft	shifts up by 1200 ft	shifts up by 2000 ft
Runoff	10% decrease	no change	>50% decrease
Timing of peak runoff	earlier by 4 weeks	earlier by 3 weeks	earlier by 5 weeks
summer monsoon	increase by 5-10%	increase by 10%	decrease by 20%
Summer like 2002	every 2 years	every 10 years	every summer
Severe drought duration	1-2 years	1 year	1-8 years
2002/2012 Drought	every 3 years	every 10 years	every 2 years
Strong El Nino return frequency	doubles	no change	no change

4.2 ADAPTATION AND CONSERVATION SCENARIOS

Based on the climate predictions and anticipated environmental response, we created three plausible scenarios that also capture a range of future anthropogenic influences. The primary human influences on GUSG and their habitat are residential development, associated infrastructure and roads, recreation, and grazing. Oil and gas development, other mining, and changes to the Conservation Reserve Program (CRP) also affect GUSG in specific populations or to a lesser degree. Residential development and population growth are expected to continue into the future (GSRSC 2005, pp. 150-153) The year 2050 projected human population for the entire Gunnison River Basin is expected to be 2.3 times greater than the 2005 population, with Mesa and Montrose Counties being the most populous in that area (Colorado Water Conservation Board 2009, pp. 15, 53). Rangewide population growth estimated at 57.8 percent

from 1985-2012. We anticipate the infrastructure and road development associated with residential development and regular maintenance to continue as well. Presently, grazing management within most populations maximizes understory growth and health to benefit livestock as well as GUSG. However, cattle grazing practices in Sims Mesa and sheep grazing in Crawford are negatively affecting GUSG habitat.

Table 8. Future Scenarios to 2035 and 2050.

2035/2050	Continuation	Optimistic	Pessimistic
Climate Scenario	Moderately Hot	Wet and Warm	Hot and Dry
Residential development	Mix of high/moderate density and rural development continues at current rates.	Development is at lower rates and is high-density housing, concentrated in city centers.	Unchecked, increased rural development. Large properties converted to subdivisions.
Infrastructure and road development	Current rate of infrastructure and road development.	Decreased infrastructure and road development.	Increased infrastructure and road development.
Sagebrush	Slowly sagebrush decline with increased temperature and decreased precipitation.	Increased precipitation may cause sagebrush die off in some areas, expansion in others.	Increased rate of decline with increased drought conditions.
Invasive plants	Invasive plant species spread, increasing in populations where it is already an issue. Spread is slow in higher elevations (Gunnison, Poncha Pass)	Invasive plants increase in diversity and expand range wide. Native plants also thrive with increased precipitation.	Significant spread throughout all GUSG range as invasive plants are more tolerant of drought and replace areas post-wildfire.
Piñon-Juniper	PJ/conifers stay the same, or decrease slowly.	PJ/conifers gradually expand into sagebrush.	Piñon decline slowly, Juniper replaces piñon pine.

Table 9 summarizes potential future scenarios without considering conservation. To evaluate the influence of potential conservation actions for GUSG, we took the greatest influences on GUSG populations to create three corresponding conservation scenarios, which vary in measures taken, and magnitude of action. Table 10 summarizes the conservation scenarios.

Conservation Scenario 1 follows a "continuation" set of actions, so current actions will be carried forward in the same scope and magnitude. Conservation Scenario 2 follows an "optimistic" or heightened conservation set of actions, and Conservation Scenario 3 follows a "pessimistic" or decreased set of conservation actions.

Table 9. Conservation Scenario 1 follows a "continuation" set of actions, Conservation Scenario 2 follows an "optimistic" or heightened conservation set of actions, and Conservation Scenario 3 follows a "pessimistic" or decreased set of conservation actions.

Influence	Conservation Scenario 1 – Continuation, no change in conservation from current	Conservation Scenario 2 – Optimistic, more and improved conservation	Conservation Scenario 3 – Pessimistic, reduced conservation
Regulatory Mechanisms and Residential Development	Most counties (except Montrose and Ouray) have planning for GUSG and restrictions.	All counties (except Ouray) implement development restrictions in GUSG habitat, possibly adopting Habitat Prioritization Tool to assist. Affordable housing plans encourage higher density residential development.	Counties continue in fashion of Montrose, decreasing regulatory mechanisms or existing mechanisms are ineffective. No restrictions on location/placement of new infrastructure.
Infrastructure and Roads	New infrastructure and maintenance stay within current ROWs; lines are buried for residential development.	New developments and maintenance stay in existing disturbance footprint in GUSG habitat and/or has mitigation.	Increased, new infrastructure and road development without constraints of GUSG habitat.
Invasive Plants	Desire to control invasive plants/cheatgrass in Dry Creek Basin but funding not consistently available. Opportunistic invasive treatments occur in all other populations including Gunnison Basin.	Effective range-wide weed management (funding and implementation).	invasions continue without effective management solutions
Mesic habitat restoration	Mesic habitat restoration continues as possible. Primary focus in Gunnison Basin, slowly implemented in other populations based on TNC modeling and ground-truthing/availability.	Use TNC modeling effort/ground-truthing to prioritize mesic and riparian restoration efforts, completing all areas of highest restoration potential.	Few more mesic/riparian projects continue.
Piñon-Juniper Encroachment	Continue to implement opportunistically with available funding, limited by land access.	PJ removal and management is prioritized for high threat areas, especially CSCSM, Crawford, Dove Creek, Monticello, and	Few treatments occur.

		San Miguel (Dry Creek Basin, Miramonte, Beaver Mesa, Iron Springs)	
Recreation	Current closures/enforcement continue, road decommissioning as possible	Tighter restrictions and enforcement on recreation activities, especially in Gunnison, CSCSM, and Crawford and targeted effort to decommission old roads and reseed/vegetate	No increase in enforcement, population growth increases recreation pressures.
Public Grazing Management	Continuation of current management. Improper grazing practices only occur in Crawford (sheep) and CSCSM (cattle).	Incorporate GUSG habitat guidelines into monitoring/RMPs. Sheep are removed or reduced from Crawford and grazing practices improved in CSCSM.	Continuation of current management increased grazing pressures.
Population Augmentation	Plan for translocations is developed and implementation started. Populations with public/state owned lands receive translocated birds from Gunnison Basin. No translocations in CSCSM or Monticello.	Translocation and/or captive rearing program are established and operational range-wide to maximize populations at or above target HMC.	None.
Conservation Easements	% of habitat protected in CE's stays the same as present	Especially in populations with high % of private ownership, CE's increase	No new CE's.
CCAAs, Private lands SHAs	All lands presently enrolled in CCAA's remain and continue management in accordance.	Counties/private landowners participate in range-wide SHA/HCP to protect/restore lands and encourage responsible development.	No change or people disengage from CCAA program

4.3 Evaluation of Future Scenarios to 2035

With these nine scenarios, we evaluated the future condition for each population out to 2035, using the same methodology we used to evaluate current condition in Chapter 3. We used the conditions category table to evaluate the future condition for each habitat and demographic factor, and again calculated an overall resiliency score for each population.

4.3.1 2035 Continuation, Optimistic, and Pessimistic Scenarios with Continued Conservation

Table 10. 2035 Continuation scenario plus conservation scenario 1 (conservation stays the same).

2035 "Continuation + same conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	3	3	3	3	3.00
San Miguel	2	1	2	2	1.83
Piñon Mesa	2	2	2	2	2.00
Crawford	2	1	1	2	1.50
CSCSM	1	0	1	1	0.83
Poncha Pass	2	0	0	2	1.00
Dove Creek	1	0	0	1	0.50
Monticello	1	0	1	1	0.83

Under the 2035 continuation scenario with continued conservation (Table 11, above), one population is in high condition, two populations are in moderate condition, four populations are in low condition, and one population is in critical condition. The Gunnison Basin population is the only population that stays in high condition. The Piñon Mesa population drops to a moderate condition from high and the CSCM drops to a low from a moderate condition. The reduction in resiliency category for Pinon Mesa is due to a reduction in the habitat quality metric because of temperatures will increase and precipitation decreases under this scenario. CSCM drops from medium to low under this scenario due to decreases in the quality and quantity of habit, due to temperature increases, precipitation decreases, and ongoing residential development without county protections. Although the overall score for the Crawford population stayed in a low condition, the overall score improved slightly with a change in the HMC growth rate from critical to medium condition due to ongoing translocation efforts. Similarly, the HMC condition improved for the Poncha Pass population due to ongoing translocation efforts. Monticello remained in a low condition, and the habitat quantity dropped a condition due to ongoing residential development.

Table 11. 2035 Optimistic scenario plus conservation scenario 1 (conservation stays the same).

2035 "Optimistic + same conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	3	3	3	3	3.00
San Miguel	2	2	3	3	2.67
Piñon Mesa	2	2	2	3	2.33
Crawford	2	1	1	2	1.50
CSCSM	2	0	2	2	1.67
Poncha Pass	2	1	0	2	1.17
Dove Creek	1	0	1	1	0.83
Monticello	2	0	2	2	1.67

For all of our optimistic scenarios there is an increase in temperature, increase in precipitation, and increase in invasive plants. Under the 2035 optimistic scenario with continued conservation (Table 12, above), three populations are in high condition, three populations are in moderate condition, and two populations are in low condition. Under this scenario, the Piñon Mesa population remains in high overall condition because translocations continue and increased precipitation maintains habitat quality. However, there could be more risk for piñon-juniper encroachment, invasive plants, and fire because of the increased precipitation. The San Miguel population increases from a medium overall condition to a high condition due to increases in habitat quality from increased precipitation in the Dry Creek Basin, which will increase forb and grass availability. The San Miguel HMC also increases to reach at least the low target HMC due to improved habitat quality and translocations. Reduced residential development maintains habitat quantity in San Miguel as well. Under this scenario, the Crawford population experiences an increase in HMC growth rate, which increase the overall score to moderate health. Continued grazing pressures prevent habitat quality from improving here. The CSCSM population overall score remains the same. In this scenario, the Monticello population's overall condition increases to moderate as habitat quality improves from increased precipitation, which also improves the condition of the HMC growth rate although no birds are translocated here. Some translocations into Dove Creek are not enough to increase the HMC to low health condition, although the growth rate does improve.

Table 12. 2035 Pessimistic scenario plus conservation scenario 1 (conservation stays the same).

2035 "Pessimistic + Same Conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	2	3	3	3	2.83
San Miguel	2	1	2	2	1.83
Piñon Mesa	1	1	1	2	1.33
Crawford	1	1	1	1	1.00
CSCSM	1	0	1	1	0.83
Poncha Pass	1	0	0	2	0.83
Dove Creek	0	0	0	1	0.33
Monticello	1	0	1	1	0.83

For all of our pessimistic scenarios there is an increase in temperature, decrease in precipitation, residential development increases, and sagebrush decreases. Under the 2035 pessimistic scenario with continued conservation (Table 13, above), one population is in high condition, one populations is in moderate condition, five populations are in low condition, and one population is in critical condition. The Gunnison Basin population is the only population that stays in high condition. The San Miguel population remains at a moderate condition because translocations maintain the HMC growth rate, but because of a decrease in habitat quantity due to residential development and climate pressures, the HMC does not increase. Even with translocations, the Piñon Mesa population falls to a low condition because of residential development and decrease in habitat quality due to high temperatures and low precipitation. CSCSM drops to a low from a moderate condition. CSCSM drops from medium to low under this scenario due to decreases in the quality and quantity of habit, due to temperature increases, precipitation decreases, and ongoing residential development without county protections; also, there are no translocations into CSCSM so the HMC growth rate decreases. The overall score for the Crawford population stayed in a low condition, however, the HMC growth rate changed from critical to low condition due to ongoing translocation efforts and habitat quality decreased due to grazing pressures. Similarly, the HMC condition improved for the Poncha Pass population due to ongoing translocation efforts. Even with translocation efforts into Dove Creek, habitat quantity decline from ongoing residential development keeps HMC growth rate and numbers low. The lack of habitat quantity and quality from residential development, and lack of mesic/summer habitat increases the risk of extirpation for this population. Monticello remained in a low condition, and the habitat quantity dropped a condition due to ongoing residential development.

4.3.2 2035 Continuation, Optimistic, and Pessimistic Scenarios plus Increased Conservation

Table 13. 2035 Continuation scenario plus conservation scenario 2 (increased conservation).

2035 "Continuation + increased conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	3	3	3	3	3.00
San Miguel	2	2	3	3	2.67
Piñon Mesa	2	2	2	3	2.33
Crawford	2	1	1	2	1.50
CSCSM	2	1	2	2	1.83
Poncha Pass	2	1	0	2	1.17
Dove Creek	1	0	1	1	0.83
Monticello	2	1	2	1	1.50

Under the 2035 continuation scenario with increased conservation (Table 14, above), three populations are in high condition, one population is in moderate, and four populations are in low condition. The Gunnison Basin and Piñon Mesa populations stay in high condition. The San Miguel Population increases to high condition because translocation/captive rearing efforts increase the HMC to within the low HMC target, and conservation efforts improve habitat quality despite increased temperature and climate variability. Although the overall score for the Crawford population stayed in a low condition, the overall score improved slightly with a change in the HMC growth rate from critical to medium condition, due to increased translocation efforts. Habitat quality in Crawford population stayed the same although grazing pressures are removed in this scenario due to the slow growth rates of sagebrush. Similar to Crawford, the HMC condition improved for the Poncha Pass and CSCSM populations due to ongoing translocation efforts. CSCSM also maintains habitat quantity and quality in this scenario because county protections for GUSG habitat are improved/reinstated, however mesic habitat is still limiting. Translocations into Dove Creek population help increase the HMC growth rate that is maintained by increased habitat protections. Although the Monticello population remained in a low condition overall, the score increased because of an improved HMC growth rate and HMC (3-year average). In addition, habitat quantity remained at moderate due to increased protections from residential development.

Table 14. 2035 Optimistic scenario plus conservation scenario 2 (increased conservation).

2035 "Optimistic + increased conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	3	3	3	3	3.00
San Miguel	3	3	3	3	3.00
Piñon Mesa	3	3	2	3	2.67
Crawford	2	2	1	3	2.00
CSCSM	2	1	2	2	1.83
Poncha Pass	2	1	0	2	1.17
Dove Creek	1	1	1	2	1.33
Monticello	2	1	2	2	1.83

Under the 2035 optimistic scenario with increased conservation (Table 15, above), three populations are in high condition, three populations are in moderate, and two populations are in low condition. The Gunnison Basin and Piñon Mesa populations stay in high condition, although the overall score increases for Piñon Mesa because the HMC growth rate and 3-year average improve dramatically from translocations, and high quality habitat from increased precipitation and protections from residential development. The San Miguel population increases to high condition because translocation/captive rearing efforts increase the HMC to the HMC target, and conservation efforts improve habitat quality despite increased invasive species. The Crawford population increased to a moderate condition because increased precipitation and decreased grazing improved habitat quality and translocation efforts increased HMCs. However, habitat quantity is still limiting. Similar to Crawford, the HMC condition improved for the Poncha Pass and CSCSM populations due to ongoing translocation efforts. CSCSM also maintains habitat quantity and quality in this scenario because county protections for GUSG habitat are improved/reinstated, increased precipitation could aid in improving mesic habitat even more. Translocations into Dove Creek population help increase the HMCs and elevate them to low condition that is maintained by increased habitat protections and habitat quality increases from conservation efforts and increased precipitation. The Monticello population overall score increased to moderate health in this scenario because translocations improve the HMC growth rate and 3-year average and conservation efforts coupled with increased precipitation improve habitat quality.

Table 15. 2035 Pessimistic scenario plus conservation scenario 2 (increased conservation).

2035 "Pessimistic + increased conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	2	3	3	3	2.83
San Miguel	2	2	2	2	2.00
Piñon Mesa	2	2	2	2	2.00
Crawford	2	1	1	2	1.50
CSCSM	1	1	1	1	1.00
Poncha Pass	2	1	0	2	1.17
Dove Creek	2	1	0	1	0.83
Monticello	2	1	1	1	1.17

Under the 2035 pessimistic scenario with increased conservation (Table 16, above), one population is in high condition, two populations are in moderate, and five populations are in low condition. The Gunnison Basin is the only population in high condition. Although the San Miguel population remains in moderate overall score, the score decreases, as some habitat is lost from residential development, however other habitat protections and translocation efforts help increase the HMC (3-year average). The Piñon Mesa population decreases to moderate condition because habitat quality is reduced from higher temperatures and decreased precipitation. Although the overall score for the Crawford population stayed in a low condition, the overall score improved slightly with a change in the HMC growth rate from critical to medium condition, due to increased translocation efforts. Although sheep grazing pressures are removed in this scenario, habitat quality stayed the same due to the slow growth rates of sagebrush, high temperatures, and low precipitation. Similar to Crawford, the HMC condition improved for the Poncha Pass and CSCSM populations due to ongoing translocation efforts. CSCSM habitat quality decreased to low in this scenario; despite conservation efforts, high temperatures and low precipitation limit mesic habitat and forb and grass growth. Translocations into Dove Creek population help increase the HMC growth rate and 3-year average, however development pressures exceed conservation efforts to protect habitat quantity, so habitat quantity drops into the critical category. The Monticello population remained in a low condition overall with the same score, however, habitat quantity decreased for the same reasons as Dove Creek although translocations improved HMC growth rate and HMC (3-year average).

4.3.3 2035 Continuation, Optimistic, and Pessimistic Scenarios plus Decreased Conservation

Table 16. 2035 Continuation scenario plus conservation scenario 3 (decreased conservation).

2035 "Continuation + decreased conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	2	3	3	3	2.83
San Miguel	2	1	2	2	1.83
Piñon Mesa	1	1	1	2	1.33
Crawford	0	1	1	2	1.17
CSCSM	1	0	1	1	0.83
Poncha Pass	1	0	0	1	0.50
Dove Creek	0	0	0	0	0.00
Monticello	1	0	1	0	0.50

Under the 2035 continuation scenario with decreased conservation (Table 17, above), one population is in high condition, one population is in moderate condition, four populations are in low condition, and two populations are in critical condition. The Gunnison Basin population is the only population that stays in high condition; however, the increased human development negatively affects the HMC growth rate, dropping it into a moderate category. In the San Miguel population, habitat is lost from increased residential and infrastructure development and HMCs decrease because there are no translocations. Therefore, the San Miguel population maintains a moderate overall health, but the score decreases. The Piñon Mesa population overall score drops to a low condition from high due to no translocations reducing HMCs, increased residential development reducing habitat quantity, and climate variability and lack of conservation actions affecting habitat quality. CSCM drops from medium to low under this scenario due to decreases in the quality and quantity of habit, due to temperature increases, precipitation decreases, and ongoing residential development without county protections. In this scenario the Crawford population maintains the same overall health and same scores for each metric, however, if the HMC growth rate is to continue at critical levels, by 2035 the population is at greater risk of even greater decrease in population size or extirpation. Similarly, the Poncha Pass population experiences a decrease in the HMC growth rate without translocations. Habitat quantity is already limited in Poncha Pass and without restraint on residential development, habitat quantity and quality decrease in conjunction with higher temperatures and likely reduced sagebrush/forb cover. Without conservation, the Dove Creek population is functionally extirpated, as there are no translocations to supplement the population, residential and commercial development decrease habitat quantity further fragmenting sagebrush habitat, therefore reducing habitat quality as well. Monticello follows a similar pattern as Dove Creek, the currently moderate habitat quantity decreases to low that still provides some habitat out to 2035.

Table 17. 2035 Optimistic scenario plus conservation scenario 3 (decreased conservation).

2035 "Optimistic + decreased conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	3	3	3	3	3.00
San Miguel	2	1	3	2	2.17
Piñon Mesa	1	1	2	3	2.00
Crawford	0	1	1	2	1.17
CSCSM	1	0	1	2	1.17
Poncha Pass	1	0	0	2	0.83
Dove Creek	0	0	1	1	0.67
Monticello	1	0	1	1	0.83

Under the 2035 optimistic scenario with decreased conservation (Table 18, above), one population is in high condition, two population are in moderate condition, four populations are in low condition, and one is in critical condition. Lower rates of residential development and increased precipitation maintain Gunnison Basin population in a high overall rank. Similarly, in the San Miguel population lower rates of development maintain habitat quantity. Increased precipitation helps to maintain HMCs without translocations because of increased available native forbs and grasses. However, this population is also at risk of increased piñon-juniper growth and invasive plant species without conservation actions, which is why habitat quality remained moderate. Habitat quality in Piñon Mesa population is maintained at a high level in this scenario, but is at increased risk of invasive plants and wildfires. Due to the existing small population size, the HMC growth rate and 3-year average decrease here. Increased precipitation and decreased risk of drought in this scenario help maintain habitat quality in Crawford, CSCSM, and Poncha Pass. However, the effects of small population sizes and lack of translocations decrease the HMC growth rate in Crawford, CSCSM, and Poncha Pass. Although habitat quality is slightly improved or maintained in this scenario, the effects of small population sizes and no supplementing of populations increases the risk to all populations, except Gunnison Basin.

Table 18. 2035 Pessimistic scenario plus conservation scenario 3 (decreased conservation).

2035 "Pessimistic + decreased conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	2	3	3	3	2.83
San Miguel	1	1	2	1	1.33
Piñon Mesa	1	1	1	2	1.33
Crawford	0	0	1	2	1.00
CSCSM	1	0	1	1	0.83
Poncha Pass	1	0	0	1	0.50
Dove Creek	0	0	0	1	0.33
Monticello	0	0	1	0	0.33

For all of our pessimistic scenarios there is an increase in temperature, decrease in precipitation, residential development increases, and sagebrush decreases. Under the 2035 pessimistic scenario with decreased conservation (Table 19, above), one population is in high condition, no populations are in moderate condition, five populations are in low condition, and two populations are in critical condition. The Gunnison Basin population is the only population that stays in high condition; however, the effects of climate negatively affect the HMC growth rate, dropping it into a moderate category. The San Miguel population drops from moderate to low health due to decreases in the HMCs, habitat quantity, and habitat quality. There are no translocations from the Gunnison Basin to other populations, residential development decreases habitat quantity, and high temperatures and risk of invasive plants species reduce the habitat quality to low. Piñon Mesa follows a similar trend as San Miguel, with across the board decreases in health. Although habitat quality appears somewhat resilient in the Crawford population, the severe decrease in HMC growth rate continues in this scenario, driving the overall low health. The remaining populations (CSCSM, Poncha Pass, Dove Creek, and Monticello) are all at increased risk with this scenario. Small population sizes, increased development, and increased risk of drought bring these populations into a low or critical resiliency category.

4.3.4 Summary of Future Conditions to 2035

Table 19. Summary of future population conditions to 2035. This table shows the overall score for each population in each scenario (continuation, optimistic, and pessimistic) with each conservation scenario (same, increased, and decreased).

Population Name	Current Condition	Continuation - same conservation	Optimistic - same conservation	Pessimistic - same conservation	Continuation - increased conservation	Optimistic - increased conservation	Pessimistic - increased conservation	Continuation - decreased conservation	Optimistic - decreased conservation	Pessimistic - decreased conservation
Gunnison Basin										
San Miguel										
Pinon Mesa										
Crawford										
CSCSM										
Poncha Pass										
Dove Creek										
Monticello										

Table 20, above shows the overall population resiliency scores for all scenarios analyzed out to 2035. For our continuation scenario, we see the most populations in a moderate or high resiliency with increased conservation; with increased conservation, three populations are in high health. With the same conservation, we see a reduction in Piñon Mesa from overall high resiliency to moderate and CSCSM decreases from moderate to low overall resiliency, due to environmental changes in temperature and precipitation. However, regardless of conservation, Poncha Pass, Dove Creek, and Monticello have the same overall scores as current condition (low and critical). These populations are at greater risk to stochastic events and therefore contribute less to the redundancy of the species. With low/critical conditions in these three populations, the representation in five ecoregions is reduced to three.

For our optimistic scenario, the results are very similar when conservation stays the same or increases, with Gunnison Basin, San Miguel, and Piñon Mesa having high health. However, with increased conservation, Monticello moves into a moderate health category from a low condition, and Dove Creek moves into a low health category from critical. Under this increased conservation scenario, all five ecoregions remain populated, which maintains species representation as ecological diversity across the species' range. Redundancy is also maintained with as all eight populations remain. However, with less conservation, the optimistic scenario , t] scenario maintains only one population in high health and two in moderate health, likely due to the lack of translocations and efforts to minimize effects from increased invasive plant species and/or piñon-juniper encroachment. This increases the likelihood that Crawford, CSCSM, Poncha Pass, Dove Creek, and Monticello would not remain viable beyond 2035.

Under the pessimistic scenario, temperatures are hotter temperatures, precipitation decreases, , and residential and infrastructure development increases. If conservation remains the same, only Gunnison Basin stays in high health and San Miguel remains in moderate health. With increased conservation, Piñon Mesa could achieve moderate health, but without conservation would fall into a low category. Without conservation, Gunnison Basin remains the only high health population and occupying one ecoregion. With four populations in low health and three in critical, only five of the eight populations could contribute to redundancy of the species. However, the Gunnison Basin population would provide nearly all of the genetic diversity for the species.

4.4 Evaluation of Future Scenarios to 2050

With the same nine scenarios, we extended the 2035 evaluation out to 2050, again using the same methodology we used to evaluate current condition in Chapter 3. We used the conditions category table to evaluate the future condition for each habitat and demographic factor, and again calculated an overall resiliency score for each population.

4.4.1 2050 Continuation, Optimistic, and Pessimistic Scenarios with Continued Conservation

Table 20. 2050 Continuation scenario plus conservation scenario 1 (conservation stays the same).

2050 "Continuation + same conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	2	3	3	3	2.83
San Miguel	2	1	2	2	1.83
Piñon Mesa	2	1	1	2	1.50
Crawford	1	1	1	1	1.00
CSCSM	1	0	0	1	0.50
Poncha Pass	1	1	0	1	0.67
Dove Creek	0	0	0	1	0.33
Monticello	1	0	0	1	0.50

Under the 2050 continuation scenario with continued conservation (Table 21, above), one population is in high condition, one population is in moderate condition, two populations are in low condition, and four populations are in critical condition. The Gunnison Basin population is the only population that stays in high condition; however, the HMC growth rate decreases due to environmental (drought) conditions, which we project, could reduce survivorship although overall habitat quality still meets most RCP guidelines. Additionally, translocations from Gunnison Basin to other populations begin to affect HMC growth rates. Out to 2050, residential development pressures decrease habitat in San Miguel population even with some county protections. The Piñon Mesa population drops to a low condition from high (current condition) because of habitat loss due to residential development and habitat conservation efforts maintain some habitat quality affected by high climate variability. The CSCM population drops to a critical condition from a moderate condition due to habitat loss and no translocations to supplement HMCs. The four populations in overall critical condition (CSCSM, Poncha Pass, Dove Creek, and Monticello) are the populations currently most affected by small population sizes. CSCSM and Monticello would not receive any translocated GUSG birds and current conservation efforts are insufficient to maintain or improve habitat quality significantly.

Table 21. 2050 Optimistic scenario plus conservation scenario 1 (conservation stays the same).

2050 "Optimistic + same conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	2	3	3	3	2.83
San Miguel	2	2	3	2	2.33
Piñon Mesa	2	2	2	3	2.33
Crawford	2	2	1	2	1.67
CSCSM	0	0	2	2	1.33
Poncha Pass	1	1	0	2	1.00
Dove Creek	1	0	1	1	1.00
Monticello	1	0	2	1	1.17

For all of our optimistic scenarios there is an increase in temperature, increase in precipitation, and increase in invasive plants. Under the 2050 optimistic scenario with continued conservation (Table 22, above), three populations are in high condition, one population is in moderate condition, and four populations are in low condition. The Gunnison Basin population stays in high condition; although climate variability could reduce overall habitat quality, we predict it would still meet most RCP guidelines. Out to 2050, reduced residential development pressures maintain habitat rangewide. In the San Miguel population, habitat quality stays the same due to increased precipitation but does not increase to high condition due to the increase in invasive species and piñon-juniper encroachment. Continued translocations increase the HMCs to reach the target low HMC. Under this scenario, the Piñon Mesa population remains in high overall condition because translocations continue and increased precipitation and opportunistic conservation efforts maintain habitat quality, although there is also an increase in invasive plants, fire, and piñon-juniper. The CSCM population drops to a low condition from a moderate condition due to no translocations to supplement HMCs. Poncha Pass overall score stays the same. Translocations into Dove Creek improve HMC growth rate but HMC 3-year average remains critical due to low habitat quantity and quality. Monticello overall score stays the same, this means that the HMCs would be gradually decreasing for 30 years from present, and without translocations, it is likely the HMC could reach zero before then.

Table 22. 2050 Pessimistic scenario plus conservation scenario 1 (conservation stays the same).

2050 "Pessimistic + same conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	2	3	3	2	2.50
San Miguel	2	1	2	2	1.83
Piñon Mesa	1	1	1	2	1.33
Crawford	0	1	1	1	0.83
CSCSM	0	0	0	1	0.33
Poncha Pass	1	0	0	1	0.50
Dove Creek	1	0	0	1	0.50
Monticello	0	0	0	1	0.33

For all of our pessimistic scenarios there is an increase in temperature, decrease in precipitation, residential development increases, and sagebrush decreases. Under the 2050 pessimistic scenario with the same conservation (Table 23, above), one population is in high condition, one population is in moderate condition, three populations are in low condition, and three populations are in critical condition. The Gunnison Basin population is the only population that stays in high condition; however, the effects of climate and supplementing other populations (translocations) negatively affect the HMC growth rate, dropping it into a moderate category. Additionally, increased frequency of droughts decreases habitat quality so only some of the RCP guidelines are met in Gunnison Basin. The San Miguel population remains in a moderate condition; however, the score decreases due to a decrease in habitat quantity from increased residential development. Increased drought conditions and residential development in the Piñon Mesa population reduce the effectiveness of translocations which then reduce the overall population health to low. Drought, increased residential development, and continued grazing pressure in this scenario reduce the overall health of the Crawford population. Even with translocation efforts, the steep decline in HMC growth rate continues in Crawford. CSCSM and Monticello populations do not receive translocated birds in this scenario, which indicates that the risk of extirpation is very high for these two populations since their current HMCs are in critical condition. Low habitat quality from drought furthers the risk. Although Poncha Pass and Dove Creek may receive translocated birds in this scenario, it is likely that low habitat quality and quantity are not sufficient for adequate survival and recruitment that HMCs stay critically low.

4.4.2 2050 Continuation, Optimistic, and Pessimistic Scenarios plus Increased Conservation

Table 23. 2050 Continuation scenario plus conservation scenario 2 (increased conservation).

2050 "Continuation + increased conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	2	3	3	3	2.83
San Miguel	2	2	2	2	2.00
Piñon Mesa	2	2	1	2	1.67
Crawford	2	2	1	2	1.67
CSCSM	1	1	1	1	1.00
Poncha Pass	1	1	0	2	1.17
Dove Creek	1	0	0	1	0.50
Monticello	1	1	1	1	1.00

Under the 2050 continuation scenario with increased conservation (Table 24, above), one population is in high condition, two populations are in moderate condition, four populations are in low condition, and one populations is in critical condition. The Gunnison Basin population is the only population that stays in high condition; however, the HMC growth rate decreases due to environmental (drought) conditions, which we project, could reduce survivorship although overall habitat quality still meets most RCP guidelines, especially due to summer/mesic habitat restoration projects. Additionally, translocations from Gunnison Basin to other populations begin to affect HMC growth rates. Out to 2050, residential development pressures decrease habitat in San Miguel population even with increased county protections. The Piñon Mesa population drops to a moderate condition from high (current condition) because of habitat loss due to residential development, and although habitat conservation efforts maintain much habitat quality, increased droughts reduces habitat quality. Although habitat quantity is still limiting in the Crawford population, 30 years of improved grazing management does improve the habitat quality, although not enough to improve the habitat quality score due to drought/high temperatures, it does have a positive effect (in conjunction with translocations) on the HMC growth rate and 3-year average. In this scenario, there are county protections on habitat, but current residential development rates continue. This contributes to the loss of habitat in CSCSM and the reduction in habitat quality, although translocations do improve the HMC 3-year average. 30 years of strategic translocations and/or a captive rearing program have a positive effect on the populations that currently have critical HMC health. However, limited habitat quantity in Poncha Pass and Dove Creek limit the long-term success in maintaining HMC numbers.

Table 24. 2050 Optimistic scenario plus conservation scenario 2 (increased conservation)..

2050 "Optimistic + increased conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	2	3	3	3	2.83
San Miguel	2	3	3	3	2.83
Piñon Mesa	2	2	2	3	2.33
Crawford	2	2	1	3	2.00
CSCSM	2	1	2	2	1.83
Poncha Pass	2	1	0	2	1.17
Dove Creek	1	1	1	1	1.00
Monticello	2	1	2	2	1.83

For all of our optimistic scenarios there is an increase in temperature, increase in precipitation, and increase in invasive plants. Under the 2050 optimistic scenario with increased conservation (Table 25, above), three populations are in high condition, three populations are in moderate condition, and two populations are in low condition. The Gunnison Basin population stays in high condition. Out to 2050, reduced residential development and increased precipitation maintain habitat rangewide, although more prevention of invasive plants is needed. In the San Miguel population, habitat quality becomes high due to increased precipitation and increased efforts to manage invasive species and piñon-juniper encroachment. Long-term translocations increase the HMCs to reach the target HMC. Under this scenario, the Piñon Mesa population remains in high overall condition because translocations continue and increased precipitation and conservation efforts improve habitat quality, especially mesic/summer habitat restoration and piñon-juniper removal. The CSCSM and Poncha Pass populations maintain their same overall health ranking (moderate and low, respectively), although with slightly higher scores because HMC's stabilize closer to target numbers. Translocations into Dove Creek improve HMC growth rate and HMC 3-year average, and reduced development/increased protections maintain habitat quantity. Monticello overall score increases to moderate due to translocations, maintenance of habitat quantity, and control of piñon-juniper.

Table 25. 2050 Pessimistic scenario plus conservation scenario 2 (increased conservation).

2050 "Pessimistic + increased conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	2	3	3	3	2.83
San Miguel	2	2	2	2	2.00
Piñon Mesa	2	2	1	2	1.67
Crawford	2	1	1	2	1.50
CSCSM	1	0	1	1	0.83
Poncha Pass	2	1	0	2	1.17
Dove Creek	1	1	0	1	0.67
Monticello	1	1	1	1	1.00

For all of our pessimistic scenarios there is an increase in temperature, decrease in precipitation, residential development increases, and sagebrush decreases. Under the 2050 pessimistic scenario with increased conservation (Table 26, above), one population is in high condition, two populations are in moderate condition, four populations are in low condition, and one population is in critical condition. The Gunnison Basin population is the only population that stays in high condition; however, the effects of climate and supplementing other populations (translocations) negatively affect the HMC growth rate, dropping it into a moderate category. Increased invasive plant control, wet meadow/mesic restoration, and recreation control/road decommissioning help maintain habitat quality at high despite frequent drought conditions. The San Miguel population remains in a moderate condition; however, the score decreases due to a decrease in habitat quantity from residential development although HMCs increase from translocations. Increased drought conditions and residential development in the Piñon Mesa population reduce the effectiveness of translocations that then reduce the overall population health to moderate. Success of translocations and removal of grazing slightly increases the overall health of the Crawford population, although drought conditions limit the benefits to GUSG. Although Poncha Pass and Dove Creek may receive translocated birds in this scenario, it is likely that low habitat quality and quantity are not sufficient for adequate survival and recruitment that HMCs stay low.

4.4.3 2050 Continuation, Optimistic, and Pessimistic Scenarios plus Decreased Conservation

Table 26. 2050 Continuation scenario plus conservation scenario 3 (decreased conservation).

2050 "Continuation + decreased conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	2	3	3	2	2.50
San Miguel	1	1	2	1	1.33
Piñon Mesa	1	1	1	2	1.33
Crawford	0	0	1	1	0.67
CSCSM	0	0	1	0	0.33
Poncha Pass	0	0	0	1	0.33
Dove Creek	0	0	0	0	0.00
Monticello	0	0	1	0	0.33

Under the 2050 continuation scenario with continued conservation (Table 27, above), one population is in high condition, two populations are in low condition, and five populations are in critical condition. The Gunnison Basin population is the only population that stays in high condition; however, the HMC growth rate decreases due to environmental (drought) conditions, which we project, could reduce survivorship and overall habitat quality would decrease to only meet some RCP guidelines. No translocations occur in this scenario, which in combination with increased drought conditions, continuation of residential development, and few habitat restoration and protection measures five out of eight populations are likely extirpated or functionally extirpated (Crawford, CSCSM, Poncha Pass, Dove Creek, and Monticello).

Table 27. 2050 Optimistic scenario plus conservation scenario 3 (decreased conservation).

2050 "Optimistic + decreased conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	2	3	3	3	2.83
San Miguel	1	1	2	2	1.67
Piñon Mesa	1	1	1	2	1.33
Crawford	0	1	1	2	1.17
CSCSM	0	0	1	1	0.67
Poncha Pass	0	0	0	1	0.33
Dove Creek	0	0	1	0	0.33
Monticello	0	0	1	0	0.33

For all of our optimistic scenarios there is an increase in temperature, increase in precipitation, and increase in invasive plants. Under the 2050 optimistic scenario with decreased conservation (Table 28, above), one population is in high condition, one is in moderate condition, two are in low condition, and four are in critical condition. Gunnison Basin is the only population in high health condition. Across all populations, a decrease in residential development and concentration in city-centers mostly maintains current levels of habitat quantity, although populations that were near the lower threshold of habitat quantity targets do drop into a lower condition (San Miguel, Piñon Mesa, CSCSM, and Monticello). Without significant conservation actions to control invasive weeds and piñon-juniper, habitat quality range wide decreases despite increased precipitation. Finally, CSCSM, Poncha Pass, Dove Creek, and Monticello are likely extirpated due to small population sizes not being supplemented.

Table 28. 2050 Pessimistic scenario plus conservation scenario 3 (decreased conservation).

2050 "Pessimistic + decreased conservation"	Demography		Habitat Quantity	Habitat Quality	Overall Rank
	HMC growth rate	HMC (3-year average)	Sagebrush (acres)	In relation to RCP habitat guidelines	
Gunnison Basin	1	3	3	2	2.33
San Miguel	1	1	2	1	1.33
Piñon Mesa	1	1	1	1	1.00
Crawford	0	0	1	1	0.67
CSCSM	0	0	0	1	0.33
Poncha Pass	0	0	0	1	0.33
Dove Creek	0	0	0	0	0.00
Monticello	0	0	0	0	0.00

Under the 2050 pessimistic scenario with decreased conservation (Table 29, above), one population is in high condition, two populations are in low condition, and five populations are in critical condition. The Gunnison Basin population is the only population that stays in high condition; however, the HMC growth rate decreases due to environmental (drought) conditions, which we project, could reduce survivorship and overall habitat quality would decrease to only meet some RCP guidelines. No translocations occur in this scenario, which in combination with increased drought conditions, an increase of residential development, and few habitat restoration and protection measures five out of eight populations are likely extirpated or functionally extirpated (Crawford, CSCSM, Poncha Pass, Dove Creek, and Monticello).

4.4.4 Summary of Future Conditions to 2050

Table 29. Summary of future population conditions to 2035. This table shows the overall score for each population in each scenario (continuation, optimistic, and pessimistic) with each conservation scenario (same, increased, and decreased).

Population Name	Current Condition	Continuation - same conservation	Optimistic - same conservation	Pessimistic - same conservation	Continuation - increased conservation	Optimistic - increased conservation	Pessimistic - increased conservation	Continuation - decreased conservation	Optimistic - decreased conservation	Pessimistic - decreased conservation
Gunnison Basin										
San Miguel										
Pinon Mesa										
Crawford										
CSCSM										
Poncha Pass										
Dove Creek										
Monticello										

Table 30, above shows the overall population resiliency scores for all scenarios analyzed out to 2050. For our continuation scenario, we see the most populations in a moderate or high resiliency with increased conservation; with increased conservation, one population is in high health and three populations are in moderate health. With the continuation of current conservation, we see a reduction in Piñon Mesa from overall high resiliency to low resiliency and CSCSM decreases from moderate to critical overall resiliency, due to environmental changes in temperature and precipitation. However, regardless of conservation, Poncha Pass, Dove Creek, and Monticello have the same overall scores as current condition (low and critical). These populations are at greater risk to stochastic events and therefore contribute less to the redundancy of the species. With low/critical conditions in these three populations, the representation in five ecoregions is reduced to three. The potential loss of the CSCSM population reduces connectivity between Gunnison Basin and populations to the west.

For our optimistic scenario, the results are the same when conservation stays the same or increases, with Gunnison Basin, San Miguel, and Piñon Mesa having high health. However, with increased conservation, Monticello moves into a moderate health category from a low condition, and Dove Creek moves into a low health category from critical. Under this increased conservation scenario, all five ecoregions remain populated, which maintains species representation as ecological diversity across the species' range. Redundancy is also maintained with as all eight populations remain. However, with less conservation, the optimistic scenario maintains only one population in high health and two in moderate health, likely due to the lack of translocations and efforts to minimize effects from increased invasive plant species and/or piñon-juniper encroachment. This increases the likelihood that Crawford, CSCSM, Poncha Pass, Dove Creek, and Monticello would not remain viable beyond 2050.

Under the pessimistic scenario, temperatures are hotter, precipitation decreases, and residential and infrastructure development increase. If conservation remains the same, only Gunnison Basin stays in high health and San Miguel remains in moderate health. With increased conservation, Piñon Mesa could achieve moderate health, but without conservation would fall into a low category. Without conservation, Gunnison Basin remains the only high health population and occupying one ecoregion. With four populations in low health and three in critical, only five of the eight populations could contribute to redundancy of the species. However, the Gunnison Basin population would provide nearly all of the genetic diversity for the species.

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6 APPENDICES

6.1 HIGH MALE COUNT RAW DATA AND POPULATION RESILIENCY CALCULATIONS

6.1.1 HMC Growth Rate

$$(\frac{\Delta N}{\Delta t} = rN)$$

Where ΔN is the change in population size, N, and Δt indicates the period of time. This results in the value, r, determining if a population is increasing ($r > 0$), remaining constant ($r = 0$), or is decreasing ($r < 0$) (Gotelli 2008, 5). Although this is a simplistic way to look at each population, especially because we are limited to the HMC, it indicates the trend of each population over the past 23 years.

Gunnison Basin Population $(\frac{632-587}{23}) = 1.96$
San Miguel $(\frac{43-42}{23}) = 0.43$
Piñon Mesa $\left(\frac{15-24}{23}\right) = -0.391$
Crawford $\left(\frac{18-46}{23}\right) = -1.217$
CSCSM $\left(\frac{4-5}{21}\right) = -0.0476$
Poncha Pass $\left(\frac{4-5}{20}\right) = -0.05$
Dove Creek $\left(\frac{0-34}{23}\right) = -1.478$
Monticello $\left(\frac{7-28}{23}\right) = -0.913$

Table 30. Raw HMC data provided by CPW and UDWR, 1996 to 2018.

Year	CS/C/SM	Crawford	Dove Creek	Gunnison Basin	Piñon Mesa	Poncha Pass	San Miguel	Monticello, UT
1996		46	34	587	24		42	28
1997		41	27	645	23		55	25
1998	5	55	27	685	26		91	32
1999	6	54	56	723	29	5	47	43
2000	6	50	47	638	33	1	57	57
2001	12	28	27	712	31	3	80	47
2002	8	42	20	617	27	9	78	35

2003	6	24	8	500	25	7	51	30
2004	8	26	2	498	29	8	52	31
2005	5	39	7	971	34	9	68	33
2006	10	41	15	1061	31	9	77	24
2007	7	23	6	941	25	5	66	44
2008	2	20	6	748	24	5	44	44
2009	8	16	2	778	16	4	33	37
2010	1	4	9	745	15	3	25	18
2011	6	9	12	763	13	4	19	21
2012	11	20	9	832	11	3	35	21
2013	9	22	10	848	31	0	38	15
2014	15	32	5	811	36	6	42	15
2015	11	31	1	974	35	6	59	12
2016	9	30	0	930	30	8	50	9
2017	5	22	0	755	24	5	49	9
2018	4	18	0	632	15	4	43	7

6.1.2 HMC (3-year average)

Our cutoffs for determining if a population's HMC indicated high, moderate, low, or critical health were based on the population targets created for the RCP. These targets were based on long-term population averages and the potential for GUSG to expand into vacant or potentially suitable habitat (GSRSC 2005, p. 198). We took the population targets and used the RCP population estimate equation to solve for *C,* the HMC for the population target, and the high/low targets.

$$Population\ Estimate = \frac{C}{0.53} + (\frac{C}{0.53}\ x\ 1.6)$$ (GSRSC 2005, p. 45)

If a GUSG population's current 3-year average was at or above the target, we considered it healthy. If it was within the low range of the target HMC we considered that an indicator of moderate health. If the current 3-year average HMC was less than the low target but not less than half the low target, that indicated low health. If the populations HMC was in the single digits or less than half the low target, a populations HMC is in critical health.

Table 31. Health categories based on RCP population targets specific to each population and the estimated HMC.

Health Category	
High	At or above the target HMC
Moderate	within the low range of the target HMC
Low	Less than the low target HMC
Critical	single digits or less than half of the low range target HMC

Table 32. Estimates the HMC targets based on the RCP population targets for each population and the corresponding health ranking.

Population	HMC 3-year running average	RCP Population Target	RCP HMC Targets	Health Category
CS/C/SM	6	N/A	N/A	Critical
Crawford	23	275 (159-484)	56 (32-99)	Low
Dove Creek subpopulation	0	200 (115-352)	41 (23-72)	Critical
Gunnison	772	3,000 (1,730-5,280)	612 (353-1076)	High
Pinon Mesa	23	200 (115-352)	41 (23-72)	Moderate
Poncha Pass	6	75 (43-132)	15 (9-27)	Critical
San Miguel	47	450 (260-792)	92 (53-161)	Low
Monticello subpopulation	8	300 (175-528)	61 (36-108)	Critical

Table 33. 3-year running average of HMC by population, 1996-2018. Data provided by CPW and UDWR.

Year	CS/C/SM	Crawford	Dove Creek	Gunnison Basin	Pinon Mesa	Poncha Pass	San Miguel	Monticello, UT
1996								
1997								
1998		47	29	639	24		63	28
1999		50	37	684	26		64	33
2000	6	53	43	682	29		65	44
2001	8	44	43	691	31	3	61	49
2002	9	40	31	656	30	4	72	46
2003	9	31	18	610	28	6	70	37
2004	7	31	10	538	27	8	60	32
2005	6	30	6	656	29	8	57	31
2006	8	35	8	843	31	9	66	29
2007	7	34	9	991	30	8	70	34
2008	6	28	9	917	27	6	62	37
2009	6	20	5	822	22	5	48	42
2010	4	13	6	757	18	4	34	33
2011	5	10	8	762	15	4	26	25
2012	6	11	10	780	13	3	26	20

2013	9	17	10	814	18	2	31	19
2014	12	25	8	830	26	3	38	17
2015	12	28	5	878	34	4	46	14
2016	12	31	2	905	34	7	50	12
2017	8	28	0	886	30	6	53	10
2018	6	23	0	772	23	6	47	8

6.2 HABITAT QUANTITY

For this metric, we used Southwest Regional GAP (https://swregap.org/) analysis mapping to calculate the amount of sagebrush acres in each population. We selected sagebrush vegetation types in the range of GUSG: Colorado Plateau mixed low sagebrush shrubland, inter-mountain basins big sagebrush shrubland, and inter-mountain basins montane sagebrush steppe. After selecting these vegetation types, we converted the raster to polygons, and clipped to the occupied habitat boundaries. In case of any mapping errors classifying piñon-juniper and conifer as sagebrush vegetation, we used the high-resolution conifer encroachment/tree canopy cover mapping done by Sage-Grouse Initiative (https://map.sagegrouseinitiative.com/ecosystem/tree-cover?ll=39.4140,-106.7634&overlay=tree_cover&opacity=0.80&z=6&basemap=roadmap) to remove any habitat that had conifer encroachment greater than 10%. The final step was to also remove permanent disturbances such as buildings, roads, and infrastructure (not including transmission lines), from a disturbance layer maintained by BLM. The final sum of sagebrush land cover by population was used in the graph below.

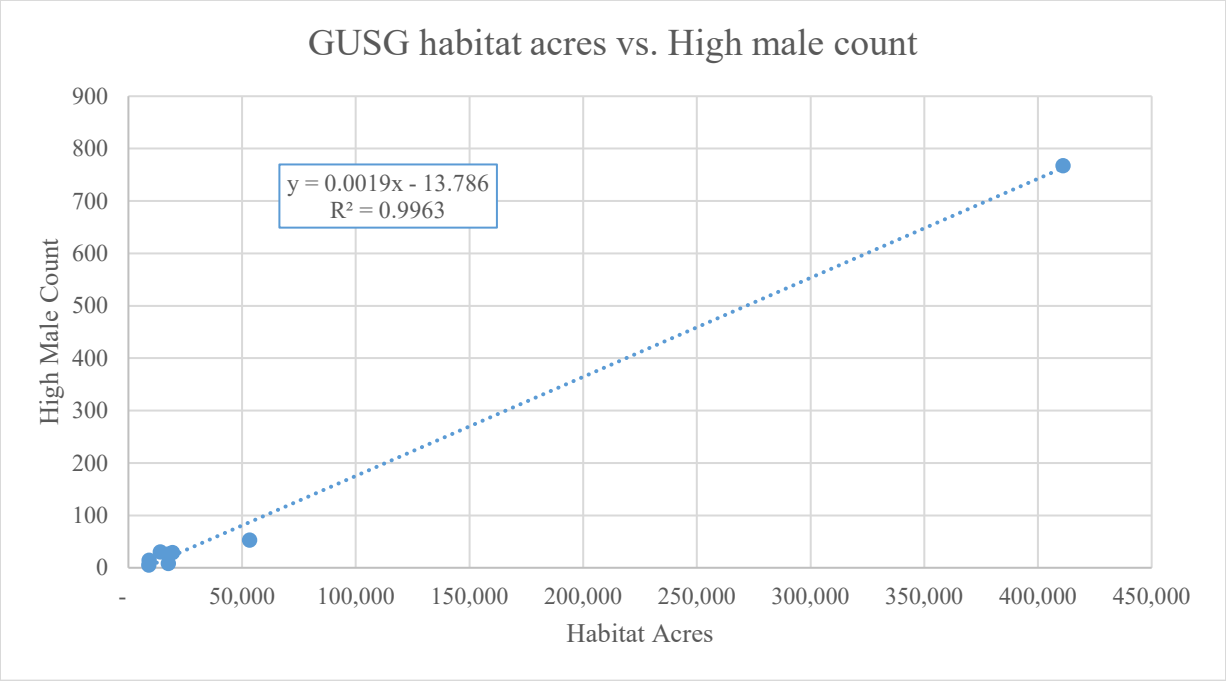

Figure 13. GUSG habitat acres compared to HMC. The slope of the line provides an estimate of the carrying capacity of habitat and number of males that could be supported. The Gunnison Basin population drives the regression line.

Table 34. Summary of HMC targets, existing sagebrush habitat, and comparison to habitat needed for HMC targets.

Population	HMC Target	HMC target (low)	HMC target (high)	Acres sagebrush habitat in occupied habitat	Habitat Quantity needed for HMC Target	Habitat Quantity needed for HMC Low Target	Habitat Quantity needed for HMC Low Target
Gunnison	612	353	1076	411119	329361	193045	573572
San Miguel	92	53	161	53397	55677	35151	91993
Pinyon Mesa	41	23	72	17395	28835	19361	45151
Crawford	56	32	99	14114	36729	24098	59361
CSCSM	28	20	36	17550	21993	17782	26203
Poncha Pass	15	9	27	9068	15151	11993	21466
Dove Creek	41	23	72	9213	28835	19361	45151
Monticello	61	36	108	19422	39361	26203	64098

6.3 COLLABORATIVE ACTION PLAN DRAFT THREAT RANKING

		OVERALL THREAT RANKING (Scope + Severity + Permanence + Immediacy)														
			Populations													
			Core	Satellite												
				Cerro Summit-Cimarron-Sims						San Miguel						
ranked order	original order	Issue Affecting GUSG	Gunnison Basin	Cerro Summit-Cimarron	Sims Mesa	Crawford	Dove Creek	Monticello, UT	Pinon Mesa	Poncha Pass	Dry Creek Basin	Hamilton Mesa	Miramonte	Gurley Res.	Beaver Mesa	Iron Sprngs
1	24	Small Population Size and Structure	4	15	16	14	16	15	14	15	15	15	15	15	15	15
2	1	Residential Development	13	14	15	13	14	9	12	12	4	7	10	14	9	14
3	25	Severe Drought and Extreme Weather	11	11	11	11	14	14	11	14	15	8	11	9	8	9
4	10	Climate Change	11	11	11	11	11	11	11	11	11	11	11	11	11	11
5	29	Loss of functionality or condition of mesic habitat	10	10	14	13	16	16	9	14	14	0	9	2	2	9
6	8	Invasive Plants	12	9	13	11	12	12	10	10	11	5	7	7	7	7
7	16	Pinon-Juniper Encroachment	4	11	11	12	12	10	8	0	12	7	10	7	10	10
8	9	Catastrophic Fire Events	9	7	10	8	8	8	10	9	8	7	8	8	8	9
10	3	Powerlines (transmission)	11	12	7	4	4	13	6	12	12	4	6	11	11	4
9	2	Roads	9	14	15	8	9	11	5	9	10	2	7	7	2	7
11	28	Late seral stages of vegetation community	10	10	11	10	10	7	0	8	11	9	2	2	5	2
12	15	Renewable Energy Development (e.g., wind, geothermal, solar)	4	7	7	4	4	16	7	4	8	4	4	4	4	6
13	26	Recreation	12	12	14	11	2	2	6	10	2	2	2	1	2	2
14	17	Conversion to Agriculture	7	U	6	7	10	12	9	4	4	4	4	4	4	4
15	14	Locatable (uranium, gold) and Salable (gravel)	4	5	9	9	8	6	5	7	8	2	2	2	2	2
16	11	Oil and Gas Development	0	5	5	5	12	6	4	0	11	6	6	3	3	3
17	4	Current Improper Domestic Grazing - Cattle	4	5	13	4	4	5	5	4	6	2	3	3	2	5
18	7	Fences	4	4	4	4	4	8	4	8	4	4	4	4	4	4
19	21	Scientific Research and Related Conservation Efforts	4	4	4	4	0	0	4	4	4	0	4	4	4	4
20	18	Large-scale Water Development and Irrigation	7	5	5	5	N/A	N/A	5	4	N/A	N/A	N/A	7	4	N/A
21	20	Lek Viewing and Counts	4	4	4	4	0	U	4	4	0	N/A	1	6	1	1
22	6	Wild Ungulate Herbivory	5	4	4	7	0	1	4	3	4	0	0	0	0	0
23	13	Other Leasable Minerals	N/A	5	5	4	12	U	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
24	30	Changes to CRP funding, practices, and enrollment	N/A	N/A	N/A	N/A	12	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25	5	Current Improper Domestic Grazing - Sheep	8	N/A	N/A	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
26	12	Coal	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
27	19	Hunting	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
28	22	Disease	U	U	U	U	U	U	U	U	U	U	U	U	U	U
29	23	Predation	U	U	U	U	U	U	U	U	U	U	U	U	U	U
30	27	Pesticides and Herbicides and Contaminants	U	U	U	U	U	U	U	U	U	U	U	U	U	U

Figure 124. Overall threat ranking (scope, severity, permanence, and immediacy) created for the Draft Collaborative Action Plan, 2018.