SPECIES STATUS ASSESSMENT

FOR THE

Coastal California Gnatcatcher
(*Polioptila californica californica*)

Coastal California Gnatcatcher (*Photo Credit: USFWS*)

U.S. Fish and Wildlife Service

Region 8 – Pacific Southwest

Carlsbad Fish and Wildlife Office

Carlsbad, California

Version 1.0

2025

RECOMMENDED CITATION

Literature citation should read as follows:

U.S. Fish and Wildlife Service. 2025. Species Status Assessment for the coastal California gnatcatcher (*Polioptila californica californica*). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. 138 pp.

ACKNOWLEDGEMENTS

This Species Status Assessment for the coastal California gnatcatcher was completed by Sandra Hamilton with extensive review and support from Gjon Hazard and Will Miller. Emilie Luciani and Bradd Baskerville-Bridges also contributed greatly to this document. Special thanks to Samantha Robinson who provided the finishing touches to complete this SSA.

The advice and assistance of many individuals, agencies, and organizations contributed to this SSA. We thank the Ventura Fish and Wildlife Office for their thorough review and contributions; Amy Vandergast, Barbara Kus, and Kristine Preston from United States Geological Survey for their research and data, which was utilized greatly in the development of this document, and for their review and feedback; and Hans Sin of the California Department of Fish and Wildlife who provided technical review. Lastly, we thank our partners who play an active role in the conservation of the coastal California gnatcatcher. Their support over the years has contributed to a better understanding of this species, which has subsequently helped develop this Species Status Assessment.

EXECUTIVE SUMMARY

This section summarizes the results of a Species Status Assessment (SSA) completed by the U.S. Fish and Wildlife Service (USFWS or Service) for the coastal California gnatcatcher. The coastal California gnatcatcher was listed as a threatened species under the Endangered Species Act of 1973, as amended (Act), in 1993 because of habitat loss and fragmentation. The coastal California gnatcatcher (*Polioptila californica californica*; gnatcatcher) is a small, non-migratory songbird in the Polioptilidae family. The gnatcatcher's range extends from Ventura County, California, south to approximately Ensenada, Baja California, Mexico at about 32° N latitude (Mellink and Rea 1994, entire; Vandergast *et al.* 2022, pp. 1210–1211). Based on new genetic information, this range is different from the range we recognized at the time of listing. In a study to assess subspecies distinctiveness, Vandergast *et al.* (2022, pp. 1210–1211) found genomic support for two distinct groups with a genetic boundary at approximately the 32°N latitude. Of birds sampled north of the 32°N latitude, 96 percent assigned to *Polioptila californica californica* with greater than 90 percent probability (Vandergast *et al.* 2022, pp. 1210–1211; see the *Genetics* section for more details). Within this range, the preferred habitat of the gnatcatcher is coastal sage scrub (CSS) plant communities.

To assess the species' viability, we used the conservation biology principles of resiliency, redundancy, and representation (together, the 3Rs). These principles rely on assessing the species at an individual, population, and species level to determine whether the species can maintain its persistence into the future and avoid extinction by having multiple resilient populations distributed widely across its range. The coastal California gnatcatcher is not uniformly distributed within the structurally and floristically variable CSS community (Atwood 1990, p. 7; USFWS 1993, p. 16751). A recent genetic analysis has revealed that most gnatcatchers in Southern California form a single, large population and remain genetically connected (Vandergast *et al*. 2019, p. 7); therefore, distinguishing biological populations was not possible. Thus, we assessed the resiliency of the gnatcatcher in six geographic units (analysis units) as a surrogate for population units. For each analysis unit, the habitat factors of suitability, quantity, and connectivity were assessed. The combined habitat condition of each unit determined the overall rangewide condition. Demographic factors were assessed at the rangewide scale and included the factors of effective population size (the number of individuals in a population that contribute genes to the next generation) and habitat occupancy. The combined habitat and demographic conditions characterize the subspecies overall resiliency. We categorized the current and future habitat and demographic conditions for each analysis unit that together represent the resiliency of the subspecies. High condition equates to a high likelihood of continued persistence, while low condition equates to an increased risk of extirpation.

Our analysis of the past, current, and future influences on the coastal California gnatcatcher needs for long-term viability revealed several factors that contribute to the subspecies' current condition and pose a risk to its future viability. These threats (or stressors) include urban and agricultural development, wildland fire, vegetation type conversion, and the effects of climate change. Under current habitat conditions, we determined the gnatcatcher has two analysis units in high condition, two in moderate condition, one in low condition in the United States, and one in Baja California, Mexico that is unknown, but likely in low condition (ES Table 1). Thus, the current overall rangewide habitat condition is moderate. For demographic factors, we determined that the gnatcatcher is currently in moderate/high condition (ES Table 1). Together, this represents a moderate/high population resiliency for current conditions.

ES Table 1. Summary Table of Analysis Unit current habitat conditions in comparison with conditions in each future scenario.[1]

Geographic Analysis Unit (AU)	Current Condition	Scenario 1	Scenario 2
Northern AU	Moderate	Low	Low
Northern Coastal AU	Low	Low	Low
Middle Coastal AU	High	High	High
Middle Interior AU	Moderate	Low/Moderate	Moderate
Southern AU	High	Moderate/High	High
Baja California, Mexico AU	Low (likely)	Low (likely)	Low (likely)
Overall condition of habitat needs	Moderate	Low/Moderate	Moderate
Overall Condition of Demographic Factors	Moderate/High	Moderate	Moderate
Population resiliency	Moderate/High	Low/Moderat[2]	Moderate

The influences on viability described above play a large role in the future resiliency, redundancy, and representation of the gnatcatcher. If analysis units lose resiliency, they are more vulnerable to extirpation, which results in losses of representation and redundancy for the species, ultimately reducing viability. The rates at which future stressors might act on specific regions and the long-term efficacy of the current conservation actions are unknown. Therefore, we forecast how a range of possible future conditions could impact the resiliency, redundancy, and representation and overall viability of the gnatcatcher. To assess future condition, we developed two plausible future scenarios. Due to a lack of information on gnatcatchers in Mexico, future forecasts were assessed for the five Southern California analysis units only. The following is a description of these future scenarios, the status of the gnatcatcher when analyzed under each scenario, and a summary of the assumptions we made under each scenario:

Scenario 1: Scenario 1 is based on an RCP 8.5 (Representative Concentration Pathway) greenhouse gas concentration scenario under hotter and drier conditions. The magnitude of threats as compared to current conditions are projected to increase. Under Scenario 1, we project that the habitat conditions in two analysis units would be low, one would be low/moderate, one would be moderate/high, and one is high, leading to an overall low/moderate habitat condition. Demographic factors would reduce from moderate/high to moderate. The combined habitat and demographic condition results in an overall low/moderate population resiliency. Conditions projected under Scenario 1 over the next approximately 50 years include:

1. RCP 8.5 emissions scenario under hotter and drier conditions, the annual maximum and minimum temperatures are projected to increase by 3.9 °C and 3.4 °C (7 °F and 6.2 °F), respectively. Precipitation is projected to decrease by 73.7 mm (2.9 inches) per year (Cal-Adapt 2018b, data).

2. Development increases approximately 25 percent throughout the range, affecting areas of suitable habitat.

3. The acres of coastal California gnatcatcher habitat burned increases approximately 20 percent rangewide.

4. The proportion of coastal California gnatcatcher habitat burning 2 or more times increases approximately 20 percent as compared to the historical baseline from 1981 to 2020.

Scenario 2: Scenario 2 is based on an RCP 4.5 concentration scenario under warmer and wetter conditions. The magnitude of threats, as compared to current conditions, are projected to increase but to a lesser degree than those in Scenario 1. Under Scenario 2, we project that the habitat conditions in two units would be low, one would be moderate, and two would be high, leading to an overall moderate habitat condition. Demographic factors would reduce from moderate/high to moderate. The combined habitat and demographic condition results in an overall moderate population resiliency. Conditions projected under Scenario 2 over the next approximately 50 years include:

1. RCP 4.5 emissions scenario under warmer and wetter conditions, the annual maximum and minimum temperatures are projected to increase by 1.9 °C and 2.0 °C (3.5 °F and 3.6 °F), respectively. Annual precipitation increases by 66 mm (2.6 in) per year (Cal-Adapt 2018a, data).

2. Development increases approximately 20 percent throughout the range, affecting areas of suitable habitat.

3. The acres of coastal California gnatcatcher habitat burned increases approximately 5 percent rangewide.

4. The proportion of coastal California gnatcatcher habitat burning 2 or more times remains the same as compared to the historical baseline from 1981 to 2020.

When compared to current conditions, our assessment of future conditions for the coastal California gnatcatcher showed a reduction in resiliency to a low/moderate condition in Scenario 1 and a maintained level of moderate resiliency in Scenario 2. Anticipated reductions in habitat conditions from increased threats (urban development, wildland fire, and vegetation type conversion) result in decreased redundancy and representation of the subspecies. There was also a decrease in demographic conditions (occupancy and effective population size) for the gnatcatcher across both scenarios. In summary, conditions in Scenario 1 indicate that the probability of persistence over the next 50 years for the coastal California gnatcatcher is compromised because of threats acting on the subspecies and its habitat. Conditions in Scenario 2 indicate the probability of persistence may be compromised by the lack of one or more needs, but the subspecies is likely to maintain the ability to withstand environmental and demographic stochasticity over the next 50 years. In both scenarios, the greatest impacts occurred in the northernmost portions of the range.

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LIST OF ACRONYMS USED

AOU……American Ornithologists' Union
BCAU……Baja California Analysis Unit
CDC……Centers for Disease Control and Prevention
CI……Confidence Interval
CSS……Coastal Sage Scrub
DoD……Department of Defense
ECOS……Environmental Conservation Online System
ESA……Endangered Species Act
FMMP……Farmland Mapping and Monitoring Program
GCM……Global Climate Model
GIS……Geographic Information System
HCP……Habitat Conservation Plan
HSI……Habitat Similarity Index
INEGI……Instituto Nacional de Estadística y Geografía
INRMP……Integrated Natural Resource Management Plan
IPCC……International Panel on Climate Change
km……Kilometer
LOCA……Localized Constructed Analogs
MCAU……Middle Coastal Analysis Unit
MCBCP……Marine Corps Base Camp Pendleton
MHCP……Multiple Habitat Conservation Program
MIAU……Middle Interior Analysis Unit
mi……Miles
MSCP……Multiple Species Conservation Program
MSHCP……Multiple Species Habitat Conservation Plan
NAU……Northern Analysis Unit
NCAU……Northern Coastal Analysis Unit
NCCP……Natural Community Conservation Planning
NGO……Non-governmental Organization
RCP……Representative Concentration Pathway
REPI……Readiness and Environmental Protection Integration Program
SAU……Southern Analysis Unit
SDMMP……San Diego Management and Monitoring Program
SSA……Species Status Assessment
USFWS……U.S. Fish and Wildlife Service
USGS……U.S. Geological Survey
USMC……U.S. Marine Corps

CHAPTER 1 - INTRODUCTION

1.1 PURPOSE OF SSA

This Species Status Assessment (SSA) was conducted by the U.S. Fish and Wildlife Service (USFWS or Service) for the coastal California gnatcatcher (*Polioptila californica californica*; gnatcatcher). The gnatcatcher is a small songbird found in Southern California, United States and northern State of Baja California, Mexico (hereafter, Baja California, Mexico). The Service listed the gnatcatcher as a threatened species in 1993.

The purpose of the SSA is to evaluate the ability of the gnatcatcher to maintain self-sustaining populations over time (i.e., viability). To assess gnatcatcher viability, we conducted an in-depth analysis of the species' ecological needs, current condition and stressors, and potential response to probable future scenarios using the conservation biology principles of resiliency, redundancy, and representation (the "3Rs"; Shaffer and Stein 2000, pp. 308-311). Resiliency is the ability of the species to withstand annual variation in the environment, representation is the ability of the species to adapt to long-term changes (i.e., evolutionary potential), and redundancy is the ability of the species to withstand catastrophic events (see *SSA Analytical Framework* section, below for more detailed description of terms). A species' viability relates to its degree of resiliency, redundancy, and representation.

We assessed gnatcatcher viability in three stages. In Stage 1, we described the species' ecology in terms of the 3Rs. Specifically, we identified the ecological requirements for survival and reproduction at the individual, population, and species levels. In Stage 2, we determined the baseline condition of the species using the ecological requirements previously identified in Stage 1. That is, we assessed the species' current condition in terms of 3Rs and identified past and ongoing factors (beneficial and risk factors) that led to the species' current condition. In Stage 3, using the baseline conditions established in Stage 2 and the projections for future risk and beneficial factors, we assessed likely future conditions of the gnatcatcher.

The intent of this report is to provide decision makers with a compilation of the best available data regarding the species biology and factors affecting its viability to inform future decisions. This report is not in itself a decisional document, but rather provides the biological information and scientific analysis as a basis to support future decisions made by the Service under the Endangered Species Act (ESA). The Service will continually update this report as new information becomes available so that it may continue to guide ESA or Act decisions regarding the coastal California gnatcatcher.

1.2 SPECIES OVERVIEW

The coastal California gnatcatcher is a small, non-migratory songbird in the Polioptilidae family, and genus *Polioptila* (Table 1). The subspecific taxonomy of *Polioptila californica* is unresolved (see *Genetics* section, below). When we listed *Polioptila californica californica,* we followed Atwood (1991, entire), who recognized the coastal California gnatcatcher as the northernmost of the three subspecies. The Service has continued to recognize the coastal California gnatcatcher as a distinguishable subspecies; however, recent information suggests that it should be circumscribed differently.

Table 1. Taxonomic Classifications of the Coastal California Gnatcatcher.

Kingdom	Phylum	Class	Order	Family	Genus	Species	Subspecies
Animalia	Chordata	Aves	Passeriformes	Polioptilidae	*Polioptila*	*P. californica*	*P. c. californica*

The gnatcatcher occupies coastal sage scrub (CSS) plant communities along the Pacific coast regions of Southern California and northern Baja California, Mexico (Atwood 1990, pp. 6–7). Previously, the *Polioptila c. californica* subspecies was recognized as occurring from Ventura County south to approximately El Rosario, Baja California at about 30 degrees north (°N) latitude (Grinnell 1926, p. 499; Atwood 1991, p. 127; AOU 1998, p. 492; Atwood and Bontrager 2020, unpaginated). As discussed in the *Historical and Current Abundance and Distribution* section, we now recognize the southern limit of the subspecies as extending to approximately Ensenada, Baja California at about 32°N latitude (Mellink and Rea 1994, entire; Vandergast *et al.* 2022, pp. 1210–1211). The range closely follows that of CSS, an ecosystem occupied with more rare species than any other California habitat and one that has historically been impacted by human activities such as urban and agricultural development (Rubinoff 2001, p. 1375; Cleland *et al.* 2016, p. 429, 439–440). Currently, 44 percent of the gnatcatcher's range in Southern California is covered by subregional Habitat Conservation Plans (HCP) permitted under section 10(a)(1)(B) of the Act, and 41 percent is also covered under the State of California's Natural Community Conservation Planning (NCCP) Act.

1.3 PREVIOUS FEDERAL ACTIONS

The Service first identified the coastal California gnatcatcher as a category 2 candidate species in 1982 and it has since been the subject of numerous *Federal Register* publications. The final rule to list the subspecies as threatened under the Act was published on March 30, 1993 (USFWS 1993, 16742–16757), and affirmed on March 27, 1995 (USFWS 1995, 15693–15699). On October 24, 2000, a final rule designated critical habitat for the subspecies (USFWS 2000, 63680–63743) which was revised in 2007 (USFWS 2007a, 72010–72213). In 2010, we received a petition to delist the coastal California gnatcatcher on the basis that it did not qualify as a taxonomically valid subspecies. In 2011, we published a 90-day finding that concluded the petition did not present substantial scientific or commercial information to indicate that delisting the coastal California gnatcatcher was warranted (USFWS 2011, 66255–66260). In 2014, we received another petition to delist the coastal California gnatcatcher that also asserted that the subspecies was not taxonomically valid. We subsequently published a 90-day finding that indicated the petitioned action may be warranted (USFWS 2014, 78775–78778). In the subsequent 12-month finding on the 2014 petition published August 31, 2016, we concluded the subspecies classification was valid and a decision to delist was not warranted (USFWS 2016a, 59952–59975). For a summary of all previous Federal actions, see the Environmental Conservation Online System (ECOS).

1.4 STATE LISTING STATUS

The State of California has not listed the coastal California gnatcatcher as threatened or endangered under the California Endangered Species Act.

1.5 FOREIGN LISTING STATUS

The Mexican government recognizes the *atwoodi* subspecies of the California gnatcatcher (see Mellink and Rea 1994 for taxonomic classification). *Polioptila californica atwoodi* was described by Mellink and Rea (1994, p. 55) as a new subspecies of California gnatcatcher ranging from Río de las Palmas eastward to Valle de las Palmas and southward to Punta Banda and Arroyo El Rosario. This described distribution overlaps and is included within the range of the listed gnatcatcher subspecies recognized by the Service (USFWS 1993, 58 FR 16742). However, based on new information, we have modified the range we recognize for *Polioptila californica californica* (see *Historical and Current Abundance and Distribution* section). Consequently, there is now only slight overlap between the *atwoodi* subspecies recognized by the Mexican government, and the *californica* subspecies recognized by the United States government. The *atwoodi* subspecies is listed as threatened by Mexico's Federal government under the NORMA oficial Mexicana NOM-059-SEMARNET-2010, Environmental Protection—Species of Wild Flora and Fauna Native to Mexico (Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo; SEMARNAT 2010).

CHAPTER 2 - METHODOLOGY

2.1 SSA ANALYTICAL FRAMEWORK

The SSA analytical framework (USFWS 2016b, entire) and the resulting SSA Report deliver an in-depth review of the species' biology and threats, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain long-term viability. While not a decisional document, the SSA report provides the foundational science for informing all Endangered Species Act (Act) decisions.

To assess the species viability, the SSA framework entails three iterative assessment stages to describe the species needs, current condition, and the species likely future condition (Figure 1). The first stage of an SSA begins with a compilation of the best available biological information on the species (taxonomy, life history, and habitat) and its ecological needs at the individual, population, and species levels based on how we understand environmental factors to act on the species and its habitat. The second stage describes the current condition of the species habitat and demographics and the probable explanations for past and ongoing changes in abundance and distribution within the species ecological settings (i.e., areas representative of the geographic, genetic, or life history variation across the species' range). The third and final stage of the SSA forecasts the species response to probable future scenarios of environmental conditions and conservation efforts. This analysis results in a characterization of the species ability to sustain populations in the wild over time (i.e., the species viability) based on the best scientific understanding of current and future abundance and distribution within the species ecological settings. The future condition analysis includes the potential conditions that the species or its habitat may face and discusses two plausible scenarios if those conditions come to fruition. This includes consideration of the factors likely to affect the species at the population or rangewide scales in the future, including potential cumulative impacts. For this assessment, we define the viability of the coastal California gnatcatcher as its ability to sustain populations in the wild currently and into the future for approximately 50 years.

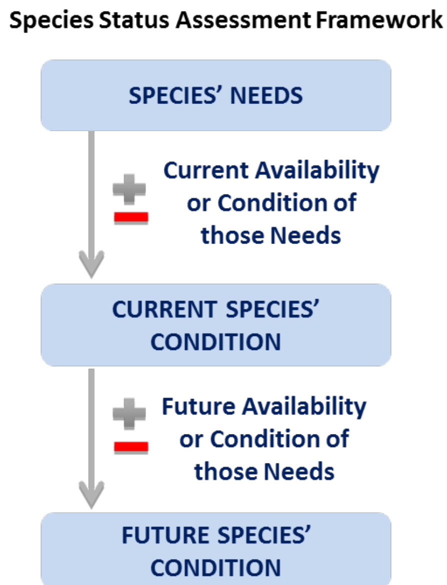

Figure 1. Species Status Assessment Framework.

Viability is the ability of a species to maintain populations in the wild over time. To assess viability, we use the conservation biology principles of resiliency, redundancy, and representation (Shaffer and Stein 2000, pp. 308–311). To sustain populations over time, a species must have the capacity to withstand:

1. Environmental and demographic stochasticity and disturbances (Resiliency),
2. Catastrophes (Redundancy), and
3. Novel changes in its biological and physical environment (Representation).

A species with a high degree of resiliency, redundancy, and representation (the 3Rs) is better able to adapt to novel changes and to tolerate environmental stochasticity and catastrophes. In general, species viability will increase with increases in resiliency, redundancy, and representation (Smith *et al.* 2018, p. 306).

Resiliency is the ability of a species to withstand environmental stochasticity (normal, year-to-year variations in environmental conditions such as temperature, rainfall), periodic disturbances within the normal range of variation (fire, floods, storms), and demographic stochasticity (normal variation in demographic rates such as mortality and fecundity) (Redford *et al.* 2011, p.

40). Simply stated, resiliency is the ability to sustain populations through the natural range of favorable and unfavorable conditions.

We can best gauge resiliency by evaluating population level characteristics such as: demography (abundance and the components of population growth rate—survival, reproduction, and dispersal), genetic health (effective population size and heterozygosity), connectivity (gene flow and population rescue), and habitat quantity, quality, configuration, and heterogeneity. Also, for species prone to spatial synchrony (regionally correlated fluctuations among populations), distance between populations and degree of spatial heterogeneity (diversity of habitat types or microclimates) are also important considerations.

Redundancy is the ability of a species to withstand catastrophes. Catastrophes are stochastic events that are expected to lead to population collapse regardless of population heath and for which adaptation is unlikely (Mangel and Tier 1993, p. 1083).

We can best gauge redundancy by analyzing the number and distribution of populations relative to the scale of anticipated species-relevant catastrophic events. The analysis entails assessing the cumulative risk of catastrophes occurring over time. Redundancy can be analyzed at a population or regional scale, or for narrow-ranged species, at the species level.

Representation is the ability of a species to adapt to both near-term and long-term changes in its physical (climate conditions, habitat conditions, habitat structure, etc.) and biological (pathogens, competitors, predators, etc.) environments. This ability to adapt to new environments—referred to as adaptive capacity—is essential for viability, as species need to continually adapt to their continuously changing environments (Nicotra *et al.* 2015, p. 1269). Species adapt to novel changes in their environment by either 1) moving to new, suitable environments or 2) by altering their physical or behavioral traits (phenotypes) to match the new environmental conditions through either plasticity or genetic change (Beever *et al.* 2016, p. 132; Nicotra *et al.* 2015, p. 1270). The latter (evolution) occurs via the evolutionary processes of natural selection, gene flow, mutations, and genetic drift (Crandall *et al.* 2000, pp. 290–291; Sgrò *et al.* 2011, p. 327; Zackay 2007, p. 1).

We can gauge representation by examining the breadth of genetic, phenotypic, and ecological diversity found within a species and its ability to disperse and colonize new areas. In assessing the breadth of variation, it is important to consider both larger-scale variation (such as morphological, behavioral, or life history differences which might exist across the range and environmental or ecological variation across the range), and smaller-scale variation (which might include measures of interpopulation genetic diversity). In assessing the dispersal ability, it is important to evaluate the ability and likelihood of the species to track suitable habitat and climate over time. Lastly, to evaluate the evolutionary processes that contribute to and maintain adaptive capacity, it is important to assess 1) natural levels and patterns of gene flow, 2) degree of ecological diversity occupied, and 3) effective population size. In our species status assessments, we assess all three facets to the best of our ability based on available data.

2.2 SPECIES NEEDS

To assess the needs of the coastal California gnatcatcher, we condense the background information and summarize the physical and biological features important to the species' viability. We review these ecological needs at the individual, population, and species level. Individual level resource needs are those life history characteristics that influence individual survival and reproductive success to allow the successful completion of each life stage. In addition to basic needs, we assess the characteristics that make the species sensitive or resilient to natural or anthropogenic influence. At the population level, we describe the resources, circumstances, and demographics that most influence the **resiliency** of a population; this includes an evaluation of the habitat and demographic needs. At the species level, we explore influences on **redundancy** and **representation** by examining how the coastal California gnatcatcher functions to maintain populations across its range.

2.3 CURRENT CONDITION

The SSA Report describes the current known condition of the coastal California gnatcatcher's habitat and demographics, and the probable explanations for past and ongoing changes in abundance and distribution across the current range. We considered the distribution, abundance, and factors influencing the viability of the species based on the "3Rs", as described above. We identified known historical and current distribution, as well as examined factors that negatively and positively influence the species. We considered the scale, intensity, and duration of threats to assess their impacts on the populations and habitat. We also ranked the magnitude and scale of potential impacts to the gnatcatcher or its habitat from a potential threat by categorizing the impact as high, moderate, or low.

We gathered information on the status and distribution of the coastal California gnatcatcher from both published and unpublished survey work from across the subspecies' range. We also reviewed the most up-to-date information on the population genetics of the gnatcatcher and its habitat. In addition, we solicited information from U.S. Geological Survey (USGS), species experts, and other groups.

2.4 FUTURE CONDITION

In the future conditions section of the SSA Report, we evaluate how the threats identified are likely to affect the species needs into the future and forecast the species' response to probable future scenarios of environmental conditions and conservation efforts. This involves an analysis and description of anticipated future environmental conditions and the projected consequences on the species' ability to sustain populations in the wild over time as based on the "3Rs". For this evaluation, the future extends only as far as we can reasonably determine that both the future threats and the species' responses to those threats are likely. For example, changes in predation, grazing, or brood parasitism may occur at any point in the future, whereas potential effects of climate change on the coastal California gnatcatcher or its habitat may not be fully realized for 30, 50, or 100 years, depending on uncertainties in modeled projections. To establish a reasonable timeframe, we consider the species' life-history characteristics, threat-projection timeframes, and environmental variability. Overall, we found that, for many threats, the likelihood and severity of future impacts became too uncertain to address beyond a 50-year timeframe. Therefore, we assess potential responses of the coastal California gnatcatcher under two future scenarios that illustrate a plausible range of environmental and conservation conditions over a 50-year timeframe.

CHAPTER 3 - SPECIES BACKGROUND AND ECOLOGY

3.1 PHYSICAL DESCRIPTION

The coastal California gnatcatcher (*Polioptila californica californica*) is a small, insectivorous bird that occupies the coastal sage scrub (CSS) habitat of Southern California and northern Baja California, Mexico. It measures approximately 11 cm (4.5 inches) and weighs 6 grams (0.2 ounces). The gnatcatcher is dark blue-gray overall with darker gray back and paler gray underparts (Figure 2). The bill is small, and the tail is long and mostly black. Adult males have a black streak above the eye and, during the breeding season, a black cap that becomes more distinct with age (Pyle and Unitt 1998, p. 282).

Figure 2. Male Coastal California Gnatcatcher.
Photo credit: Sandrine Biziaux-Scherson, used with permission.

Adult females have more brownish backs than males, which contrasts with the gray crown (Pyle and Unitt 1998, p. 283). Both sexes have a prominent white eye-ring. Juveniles of both sexes are more washed with brown with males being very slightly less brown than females (Pyle and Unitt 1998, p. 283). Gnatcatchers have several unique calls, but unlike most other passerine species, they do not have a long, complex song-like vocalization (Preston, Grishaver *et al.* 1998, p. 262). The typical call given by gnatcatchers is reminiscent of kitten's meow and more often exhibited by males, especially around nesting season (Atwood and Bontrager 2020, unpaginated).

3.2 HABITAT

Recognized for its fragrance and beauty, coastal sage scrub (CSS) is a remarkably diverse plant community that is associated with more species of concern than any other ecosystem in California (Cleland *et al.* 2016, p. 429). This includes the coastal California gnatcatcher, which is an obligate species of CSS habitat (Atwood 1990, p. 1; Bontrager 1991, p. 1; Atwood 1993, p. 151). European settlers converted much of CSS habitat to areas for grazing up until about the 1930s (Cleland *et al.* 2016, p. 430). After the 1930s, urbanization and land use changes continued to reduce the distribution of CSS and today an estimated 85–90 percent of the historical distribution has been lost (Mooney 1977, p. 487; Westman 1981, p. 182; Atwood and Bontrager 2020, unpaginated; Cleland *et al.* 2016, p. 430). Patchily distributed along coastal zones from San Francisco to El Rosario, Baja California, CSS habitat is composed of short-statured (less than 1.5-meter (4 feet)), drought-deciduous shrubs (Cleland *et al.* 2016, p. 429). These shrubs have relatively shallow root systems and a soft stem, hence the common designation: soft chaparral.

The CSS plant community is structurally and floristically variable and consists of six major regional variants based on dominant floristic associations in California and Baja California. Along a north-south gradient, the coastal scrub communities increasingly include succulent species leading to a transition to coastal succulent scrub plant communities. This transition in plant composition reflects the change from a Mediterranean-type climate in the north to a tropical-desert type climate in the south (Peinado *et al.* 1995, p. 166; Rundel 2007, p. 217). In California, from north to south, these variants are: Diablan coastal sage scrub (also called northern coastal scrub), Venturan coastal sage scrub, Riversidian sage scrub (also called inland sage scrub), and Diegan coastal sage scrub (Westman 1983, building on Kirkpatrick and Hutchinson 1977, and Axelrod 1978; O'Leary 1990, p. 25; Cleland *et al.* 2016, p. 434). Within the coastal succulent scrub communities throughout Baja California, Mexico, researchers recognize two additional variants: Martirian and Vizcainin (Westman 1983, p. 16; O'Leary 1990, p. 25; Figure 3).

Dominant species within these plant communities include *Artemisia californica* (California sagebrush), *Eriogonum fasciculatum* (California buckwheat), *Encelia californica* (California encelia), *E. farinosa* (brittlebush), *Salvia mellifera* (black sage), *S. apiana* (white sage), and *S. leucophylla* (purple sage). Other commonly occurring plants include *Isocoma menziesii* (coast goldenbush), *Bahiopsis laciniata* (San Diego sunflower), *Baccharis pilularis* (coyote brush), *B. sarothroides* (broom baccharis), *Diplacus aurantiacus* (bush monkeyflower), *Acmispon glaber* (deerweed), *Malosma laurina* (laurel sumac), *Rhus integrifolia* (lemonade berry), and *R. ovata* (sugar bush). Cactus- and succulent-type plants found include *Opuntia littoralis* (prickly pear), *Cylindropuntia prolifera* (cholla), *Ferocactus viridescens* (coast barrel cactus), and *Dudleya* spp. (live-forever) (Sawyer and Keeler-Wolf 1995, pp. 109, 114, 120–127, 133, 139, 41).

Gnatcatchers are not obligately associated with any specific plant species within the sage scrub community; however, not all sage scrub is equal with respect to gnatcatchers, which are patchily distributed throughout this plant community. The coastal California gnatcatcher occupies the three regional variants that overlap its range, which are the Venturan, Riversidian, and Diegan associations. Along with regional variation, the community composition of CSS differs at a local level which is influenced by aspect, soil texture and depth, and disturbance history (Desimone and Burk 1992, entire; Cleland *et al.* 2016, pp. 433-434). For example, a recent study found that cover of *Artemisia californica*, *Eriogonum fasciculatum*, *Salvia mellifera*, *S. leucophylla,* sunflowers and bare ground was higher at points where gnatcatchers were detected in Southern California compared to points where they were not detected, and that average coverage of grass, herbaceous vegetation, and dead woody vegetation was lower in the Orange County subregion relative to the San Diego subregion and the entire region overall (Kus et al. 2024, p. 12). Occupancy was also positively related to *Artemisia californica* and *Eriogonum fasciculatum* cover (Kus et al. 2024, p. 18). Certain plant sub-associations may be low quality or unsuitable habitat for gnatcatchers. Several studies have reported that coastal California gnatcatcher densities are highest in areas where *Eriogonum fasciculatum* or *Encelia californica* are co-dominant with *Artemisia californica.* Densities are lowest in areas dominated by *Salvia mellifera* or *Rhus integrifolia* (Roach 1989, p. 40; Atwood 1990, p. 12; ERCE 1990, p. 19, 24; Bontrager 1991, p. 4, 9; Atwood 1993, p. 151; Weaver 1998, pp. 397–398, 401, 403). While these studies suggest potential preference or avoidance of certain plant species, interpretation of the results are limited due to narrow geographic limits and small sample sizes.

The density of shrub canopy cover also factors into suitable habitat for gnatcatchers, as they typically prefer moderate shrub cover (generally greater than 40 percent) located at less than 500 meters (1,640 feet) in elevation (Anderson 1991, p. 73; Beyers and Wirtz 1997, p. 85; Winchell and Doherty 2018, p. 587; Atwood and Bontrager 2020, unpaginated). The density of shrub cover may also influence the size of gnatcatcher territories, with territory sizes increasing as cover decreases—likely due to limited resource availability. Beyers and Wirtz (1997, p. 86) speculate that the nonnative grasses and forbs that typically occupy the gaps between shrubs do not support a sufficient insect fauna and there are probably differences in insect availability among shrub species as well, which may explain shrub species preferences by gnatcatchers.

Although coastal California gnatcatchers prefer and occupy CSS habitat, they occasionally use non-CSS habitat. As detailed by Campbell *et al.* (1998, pp. 421–433), use of habitat areas adjacent to CSS has been observed throughout the year, but especially during the non-breeding season and at the time of fledging and several months following. The use of non-CSS habitat by gnatcatchers also increases in areas where CSS habitat is lower quality (Campbell *et al.* 1998, p. 427). According to Campbell *et al.*, the use of non-CSS during the non-breeding season may be attributed to 1) increased food resources, especially during the summer-deciduous months or times of food stress; 2) a method of heat avoidance and water seeking; 3) lower predation rates due to increased cover (Campbell *et al.* 1998, pp. 426–430). Additionally, the use of non-CSS habitat is important as corridors for dispersal between larger "core" areas of CSS, especially at the juvenile stage (Bontrager 1991, p. 11; see *Dispersal and Spatial Distribution* section, below).

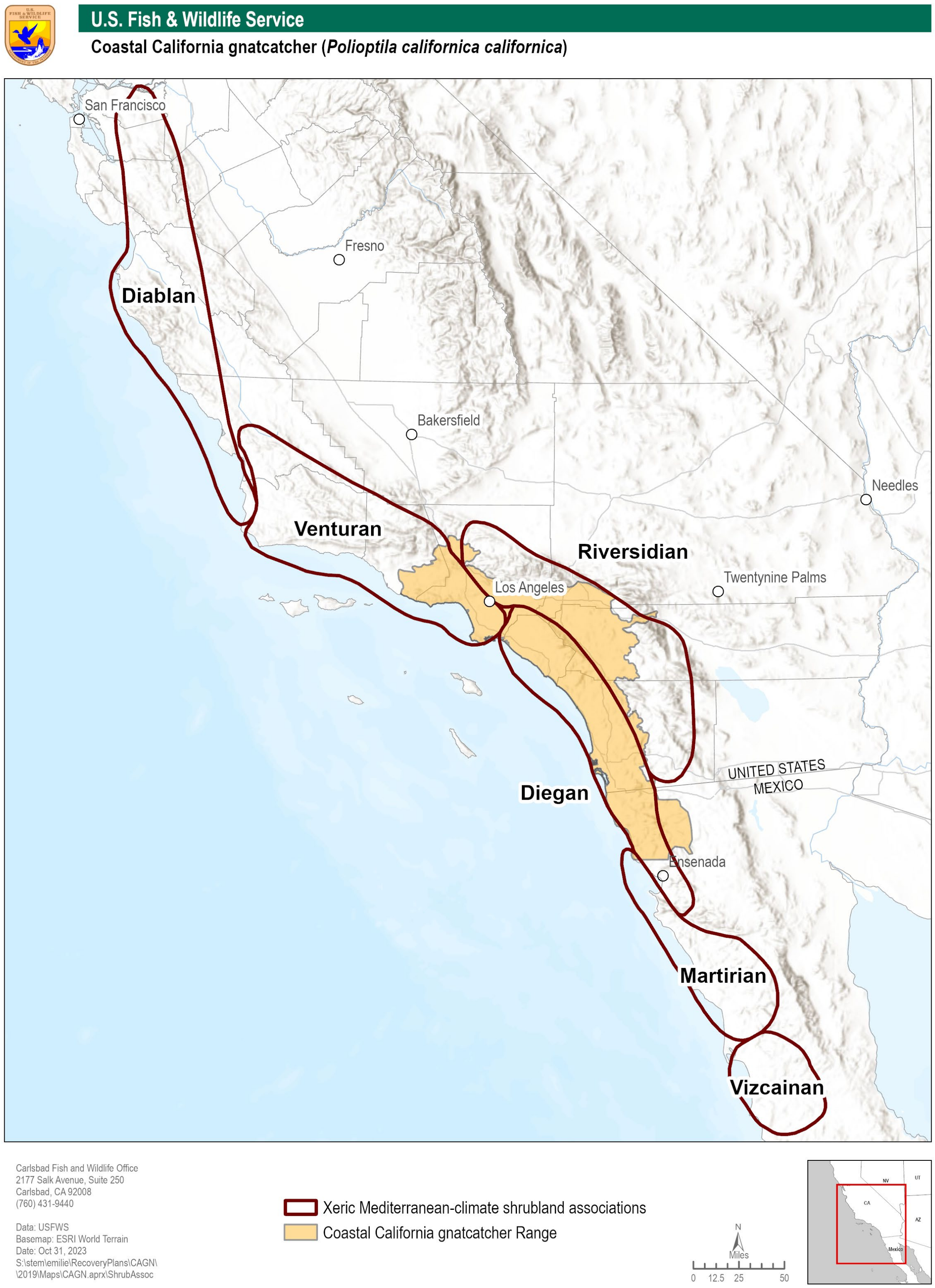

Figure 3. Map of coastal California gnatcatcher range in Southern and Baja California with the six major variants of coastal sage scrub outlined in red from Westman 1983.

3.3 GENETICS

Subspecies Taxonomy

The California gnatcatcher species is distributed from Ventura County, California in the United States to the southern tip of the Baja California Peninsula, Mexico. The number and geographic limits of California gnatcatcher subspecies have been a subject of debate in literature, and researchers have proposed multiple subspecies circumscriptions (see Atwood 1988, 1991; Mellink and Rea 1994). Based on various interpretations of morphological data, the number of California gnatcatcher subspecies have ranged from three to five. The southern limit for the northernmost subspecies, the coastal California gnatcatcher (*Polioptila californica californica*), has been described at both 30°N latitude (Atwood 1991, entire) and 32°N latitude (Mellink and Rea, 1994, entire; Vandergast *et al.* 2022, pp. 1210–1211). We have previously followed the treatment of Atwood (1991, entire) and used the 30°N latitude line; however, given updated genetic information (described in depth below), for the purposes of this assessment, we will recognize the 32°N latitude line as the southern limit for the coastal California gnatcatcher subspecies.

Since listing, the debate on the subspecies taxonomy of the California gnatcatcher has continued. Several authors have questioned whether *Polioptila californica californica* is distinguishable from other California gnatcatcher subspecies. If not, *P. c. californica* would not be a listable entity under section 3(16) of the Act. Based on genetic studies of mitochondrial and nuclear DNA, Zink *et al.* (2000, entire; 2013, entire) concluded that the California gnatcatcher was monotypic and that recognition of any subspecies was not supported. Relying heavily on these publications, we received petitions to remove the coastal California gnatcatcher from the List of Threatened and Endangered Species in 2010 and 2014 (Pacific Legal Foundation 2010, entire; Thornton and Schiff 2014, entire). Our subsequent 90-day finding on the 2010 petition upheld the coastal California gnatcatcher as a taxonomically valid subspecies and determined the petition did not present substantial scientific or commercial information to indicate that delisting the coastal California gnatcatcher was warranted (USFWS 2011, 76 FR 66255). In response to the 2014 petition, we made a positive 90-day finding. For the subsequent 12-month finding, we convened an independent scientific panel to review available data concerning the subspecies designation of the coastal California gnatcatcher. Citing significant concerns with the methods used and the interpretations of the results, along with information from the public, peer reviewed publications, and an independent science panel, we found the petition did not provide sufficient information to support the petition's assertion that the coastal California gnatcatcher is not a valid subspecies and was listed in error (USFWS 2016a). Consequently, we continued to recognize the coastal California gnatcatcher as a distinguishable subspecies; for a more thorough review of the information presented in the petitions and our reasoning for upholding the subspecies status, please see the 2011 90-day finding (USFWS 2011, 76 FR 66260) and the 2016 12-month finding (USFWS 2016a, 81 FR 59952).

More recently, additional genetic analysis assessing the rangewide genetic structure and subspecies differentiation in the California gnatcatcher supported retaining the coastal California gnatcatcher as a distinct subspecies (Vandergast *et al.* 2022, pp. 1213–1214). Utilizing four approaches to test for subspecies distinctiveness, the researchers found genomic support for two distinct groups with a genetic boundary at approximately the 32°N latitude (Vandergast *et al.* 2022, pp. 1210–1211). When testing for posterior probabilities of assignment, nearly all individuals (96 percent) sampled north of 32°N assigned to *Polioptila californica californica* with greater than 90 percent probability of assignment. South of this delineation, individuals were generally admixed, meaning almost none could be assigned to any one subspecies (Vandergast *et al.* 2022, pp. 1210–1211; Figure 4).

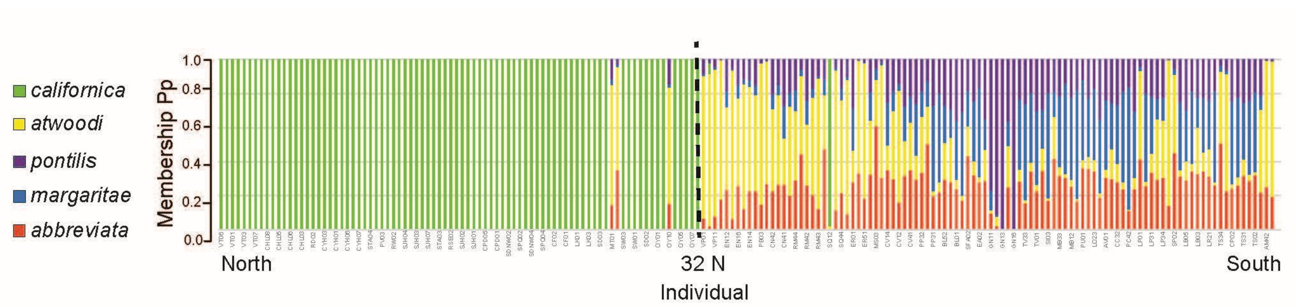

Figure 4. Discriminant Analysis of Principal Components (DAPC) Posterior Probabilities of Assignments.[1]

Although the recent genomic study was not a taxonomic assessment., we continue to recognize the nominate subspecies, *Polioptila californica californica,* as a distinguishable taxon at the subspecies rank at this time. However, given the available information (Mellink and Rea 1994, entire; McCormack and Maley 2015, p. 383; Vandergast *et al.* 2022, pp. 1210–1211), we conclude that it is more appropriate to consider the southernmost geographical limit to the subspecies' range to be about 32°N latitude, just north of Ensenada, Baja California. It would be helpful if taxonomists, using an integrative taxonomic approach, reviewed the available data rangewide and published in a peer-reviewed journal, a reassessment of California gnatcatcher subspecific taxonomy.

The researchers additionally assessed associations between climate variables and genetic variation to determine if climate-related selection pressure is driving genetic differentiation throughout the range. In general, Southern California experiences lower temperatures and higher precipitation than the Baja California Peninsula. In their assessment of climate-adapted loci, the researchers noted that the genotype of birds in the northernmost portion of the range (i.e., Ventura, Chino Hills, and Coyote Hills) appear to be associated with greater seasonal extremes of temperature and precipitation (Vandergast *et al.* 2022, p. 1212–1213). The observed genetic differences may indicate an adaptive significance (Vandergast *et al.* 2022, p. 1213).

3.4 FOOD, WATER, NUTRIENTS

The coastal California gnatcatcher is an insectivore that gleans its prey from the leaves and stems of plants commonly found in sage scrub habitat (Burger *et al.* 1999, p. 309). Gnatcatchers exhibit

[1] DAPC arranged from North to South with a dashed line at 32°N. Almost all individuals north of 32°N were assigned with high probability (>0.9) to *P. c. californica*. Almost no individuals south of 32°N could be assigned with high probability to their respective subspecies (Figure and caption from Vandergast *et al.* 2022, p. 1212)

opportunistic foraging behavior, mostly capturing sessile prey through a systematic search of shrub branches and rarely catching prey in flight (Woods 1949, p. 380; Burger *et al.* 1999, p. 309). In an analysis of fecal samples from gnatcatchers in coastal San Diego County, gnatcatcher diet consisted of Orthoptera, 37 percent; Araneae, 18 percent; Coleoptera, 15 percent; and Homoptera, 9 percent (as proportion of diet by biomass; Burger *et al.* 1999, p. 308). When foraging for chicks, adult gnatcatchers choose significantly larger prey to feed chicks than consumed by themselves (Burger *et al.* 1999, p. 308). Burger *et al.* (1999, p. 308) suggested that this may be important to reduce the risk of nest predation, as adults bringing larger prey less frequently would attract less attention to the nest than adults bringing smaller prey more frequently. Less frequent trips are also more cost effective energetically by promoting fewer back and forth trips between foraging sites and the nest site (Burger *et al.* 1999, p. 308).

Figure 5. A Foraging Female Coastal California Gnatcatcher.
Photo credit: Sandrine Biziaux-Scherson, used with permission.

Gnatcatchers spend most of their time foraging during both breeding and non-breeding seasons (Mock and Bolger 1992, p. A-21). Out of all time foraging, a majority occurred within *Artemisia californica*, *Eriogonum fasciculatum*, and *Malosma laurina* (Mock and Bolger 1992, p. A-18). Clark et al. (2023, unpaginated) also observed preference for *Baccharis pilularis* and *Brickellia californica* during the fall, with a shift towards *Artemisia californica* in the winter. Gnatcatchers will forage in more mesic habitat when drought-deciduous foliage declines around July through August (Atwood and Bontrager 2020, unpaginated). These non-CSS habitats are theorized to provide improved food resources, higher survival of dispersing juveniles, fire avoidance, and a means to alleviate heat stress (Campbell *et al.* 1998, p. 432). Use of these areas seems to be highest post-fledging and continues throughout the fall and winter (Campbell *et al.* 1998, p. 432). Gnatcatchers do not seem to seek out standing water for either drinking or bathing, but will use water collected in the leaves of sage scrub plants after a drizzle or fog (Woods 1921, p. 173; Woods 1949, p. 380; Atwood and Bontrager 2020, unpaginated).

3.5 REPRODUCTION

First-year coastal California gnatcatchers typically establish year-round territories and pair bonds by late October (Preston, Mock *et al.* 1998, p. 249). Territory size has been observed to vary based on the season (breeding versus non-breeding season) and location (coastal versus inland populations; see *Dispersal, and Spatial Distribution* section below) (Bontrager 1991, Mock and Bolger 1992, Preston *et al.* 1998, Atwood 1998). Pairs remain monogamous year-to-year as long as both members survive; in the case of a lost mate, most individuals find a new mate within the same breeding season (Atwood and Bontrager 2020, unpaginated). According to Atwood and Bontrager (2020, unpaginated), the mean annual survivorship of breeding adults is 52 to 57 percent and can vary considerably year to year, likely dependent on weather (Mock 1998, p. 413; Atwood, Tsai *et al.* 1998, p. 346). Breeding season of the gnatcatcher generally occurs from late February through July, and occasionally extends later in the year. Both sexes participate in all aspects of nest construction and care of young; however, males initiate nest building and select the nest site, and females typically incubate the eggs for longer periods.

Figure 6. A Male Coastal California Gnatcatcher Incubating Eggs.
Photo credit: Sandrine Biziaux-Scherson, used with permission.

Nest building peaks throughout April and May, but may continue throughout June, especially if re-nesting due to nest failure is needed (Atwood 1990, p. 14; Grishaver *et al.* 1998, p. 303; Atwood and Bontrager 2020, unpaginated). Gnatcatchers construct nests over a period of 4 to 10 days using various materials including grasses, bark strips, leaves, spider webs, and down (Atwood 1990, p. 17). Nests are small, deep, and cup-shaped with a slightly constricted top and are generally placed approximately 1 meter (3 feet) above the ground (Bendire 1887, p. 549; Woods 1921, p. 173, pp. 375–376; Atwood and Bontrager 2020, unpaginated). The plant species in which gnatcatchers place their nests is relative to plant availability within the gnatcatcher's habitat (Grishaver *et al.* 1998, pp. 301–302). In the case of nest failure, the species rapidly and repeatedly re-nests following loss of eggs or juveniles. In one study, Roach (1989, p. 35), noted that late season nests (thought to be built by re-nesting gnatcatchers) were more likely to produce fledglings than early season nests (Roach 1989, pp. 35–36). Occasionally, gnatcatchers will double clutch, and the number of successful nests (producing at least one fledgling) can vary from one to three (Atwood and Bontrager 2020, unpaginated). However, double clutching in gnatcatchers, when it occurs, is likely driven by annual environmental variation (i.e., wet versus dry years) which can influence resource availability and habitat quality (Grishaver *et al.* 1998, p. 314). In observations of eggs in one study, 36 percent of eggs observed produce fledglings; demonstrating a similar success rate to other open-nesting passerine species (Roach 1989, p. 35). Average survivorship of fledglings to 1 year is 29 percent (based on a closed Los Angeles County population with limited habitat; Atwood and Bontrager 2020, unpaginated).

Egg laying takes place as early as late March or as late as July; each clutch averages three to four eggs (Grishaver *et al.* 1998, p 304–305). Researchers have noted a positive association between the amount of rainfall in the month prior to clutch completion and clutch size (Grishaver *et al.* 1998, p. 305; Patten and Rotenberry 1999, p. 878). Egg formation in birds requires energy expenditure and nutrients such as fat, protein, water, and calcium; when these resources are reduced, the ability to produce eggs is reduced as well (Patten and Rotenberry 1999, p. 878). When rainfall levels fall, especially during oogenesis, this limits the gnatcatchers' prey base, thus reducing nutrient availability resulting in lower clutch sizes.

The hatchling and nestling stages take approximately 10 to 15 days total, with both males and females participating in brooding and feeding (Grishaver *et al.* 1998, p. 308). The fledgling stage lasts up to 5 weeks, though shorter if the parents attempt to raise another brood (Grishaver *et al.* 1998, p. 309). During fledging, gnatcatchers begin to develop searching behavior but remain dependent on adults for food (Grishaver *et al.* 1998 p. 309). The immediate post-fledging stage experiences the highest rates of mortality (Grishaver *et al.* 1998, p. 309). See Figure 7 for an overview of the life cycle and needs of the gnatcatcher from egg to adult.

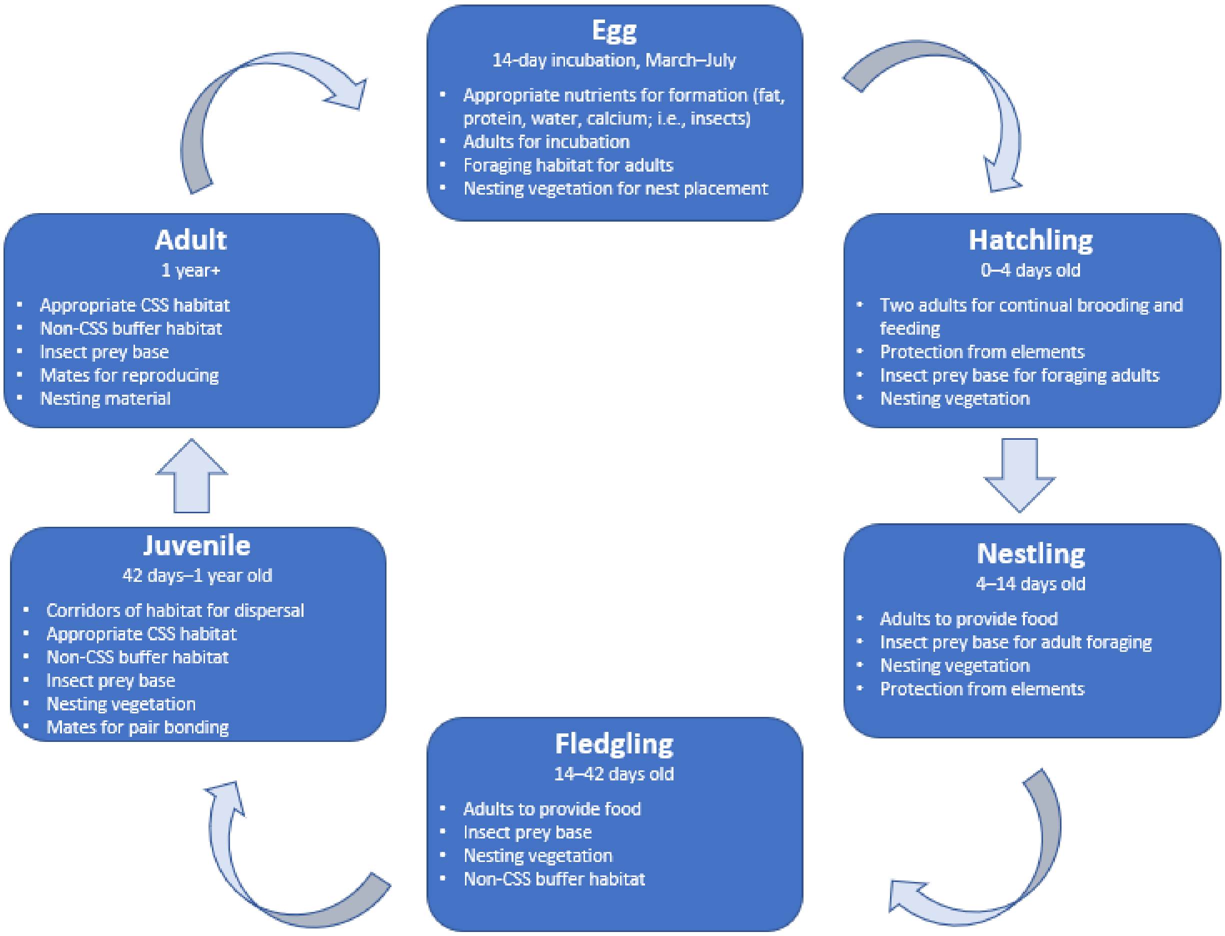

Figure 7. California Gnatcatcher Basic Life History Model and Needs of Each Life Stage.

3.6 DISPERSAL AND SPATIAL DISTRIBUTION

Once parents chase fledglings out of their territory, juveniles disperse to find their own foraging and nesting territories. Based on banding studies, juveniles are capable of dispersing distances of up to 22 km (14 mi) (Bailey and Mock 1998, p. 358), but generally tend to disperse within 3 km (1.9 mi) of their natal site (Atwood, Bontrager, Fugagli *et al.* 1998, p. 27; Bailey and Mock 1998, p. 359; Galvin 1998, p. 327; Atwood and Bontrager 2020, unpaginated). However, recent genetic analysis of individuals throughout Southern California suggests gnatcatchers may be able to disperse farther than previously estimated. Vandergast *et al* (2019, p. 7). assessed the locations of first order relatives (full siblings or parents and offspring) to infer dispersal distance and found distances between relatives of up to 133 km (83 mi) from each other (Euclidean geographic distance; Range: 0.09–133 km (0.05–82.6 mi), average: 29.9 km (18.5 mi), median: 4.9 km (3.0 mi)). When the distance was calculated using a least cost estimate of suitable habitat, the dispersal distance between relatives increased to 214 km (133 mi; range: 0.09–214 km (0.05–133 mi), average: 44.7 km (27.7 mi), median: 6.8 km (4.2 mi)) although the dispersal distances for both methods were skewed toward smaller distances (Vandergast *et al.* 2019, p. 3).

Juvenile dispersal maintains genetic exchange between subpopulations, in turn supporting the species resiliency. Dispersal of juveniles requires a corridor or linkage of native vegetation between larger patches of appropriate sage scrub vegetation (i.e., core areas) that provide foraging and shelter requisites (Soulé 1991, p. 92). These dispersal corridors facilitate the exchange of genetic material and provide a path for recolonization of areas from which the species has been extirpated (Soulé 1991, p. 92; Galvin 1998, p. 323). The need for dispersal corridors between core areas of suitable habitat was additionally supported by the findings of Vandergast et al (2019). When assessing first order relatives within the northern portion of the range (specifically, Ventura, Palos Verdes, and Coyote Hills), related pairs were found exclusively in those locations and not shared with other locations, indicating increased isolation and decreased dispersal compared to the more southern portions of the range. This is likely a result of urban development, which has more heavily impacted the northern portion of the range, resulting in decreased dispersal ability compared to the more southern portions of the range (Vandergast et al. 2019; p. 7).

The quality of natal habitat will also influence how far juveniles may disperse. For instance, in more urbanized and fragmented landscapes, juveniles may need to move greater distances to reach suitable habitat than birds fledged on territories located in a more natural vegetation matrix (Atwood, Bontrager, Fugagli *et al.* 1998, p. 34). In these cases, juveniles will disperse across fragmented and highly disturbed sage scrub habitat, such as those found along highway and utility corridors or remnant mosaics of habitat adjacent to developed lands (Bailey and Mock 1998, p. 359; Famolaro and Newman 1998, p. 451; Galvin 1998, p. 330).

As adults, gnatcatchers maintain relatively large territories for a songbird of its size (ERCE 1991, p. 6). The size of the territory a gnatcatcher will maintain varies depending on whether it is during the breeding season and if it is in a coastal or inland area. Territory size generally ranges between 2 to 14 acres (ac) (1 to 6 hectares (ha)), though they can be as large as 39 acres (15 ha) during the breeding season (Atwood 1990, pp. 14–15; ERCE 1990, pp. 13–14; Bontrager 1991, p. 12; ERCE 1991, p. 6; Preston, Mock *et al.* 1998, p. 251). In general, gnatcatchers maintain smaller territories during the breeding season than during the non-breeding season, and inland birds tend to maintain larger territories than coastal birds (ERCE 1991, p. 6; Preston, Mock *et al.* 1998, p. 251). A combination of factors likely determines the size of coastal California gnatcatcher territories, such as plant species composition, shrub density, overall habitat quality and level of disturbance, presence or absence of neighboring gnatcatchers, and inappropriate adjacent habitat (Bontrager 1991, p. 12; ERCE 1990, p. 24).

In addition to the vegetative characteristics that limit the spatial distribution of gnatcatchers on the landscape, gnatcatchers are also influenced by abiotic factors such as precipitation and temperature (especially cold temperatures). Colder temperatures and increased rainfall during the winter months are associated with gnatcatcher mortality, suggesting a physiological limitation (Mock 1998, p. 414). The current distribution of gnatcatchers appears to be limited to areas with a January mean minimum temperature of 2.5 °C (Mock 1998, p. 415). This also has a bearing on the maximum elevation in which gnatcatchers can survive, with CSS above 500 meters (1,640 ft) elevation supporting sparse numbers of gnatcatchers. In summary, the distribution of gnatcatchers is limited, at least in part, to physiological limitations of the birds' ability to survive in colder, wetter weather.

3.7 HISTORICAL AND CURRENT DISTRIBUTION

The habitat occupied by the coastal California gnatcatcher closely follows that of vegetation characterized as coastal scrub throughout Southern California and just south of the U.S.–Mexico border at 32°N latitude. The northern and eastern limits of the coastal scrub communities used by the gnatcatcher are largely bound by mountainous areas and the southern limit is just south of the urbanized Tijuana region.

In the 2016 12-month finding, we presented an updated estimate of the range of the coastal California gnatcatcher compared to the map in the 2010 5-year review (USFWS 2010, Figure 1 therein). Since then, we have again updated our range line for the coastal California gnatcatcher based on recent genetics, habitat, and occurrence information. The greatest change to our updated range is at the southernmost range limit, which has been updated to reflect the subspecies delimitation at the 32°N latitude line (Figure 8; see the *Genetics* section for more detail). To update the northern and eastern range limits of the coastal California gnatcatcher in Southern California, we used a combination of gnatcatcher occurrence locations from our database, habitat modeled as high or very high quality (Preston *et al.* 2020, entire), and elevation data (610 meters (2,000 feet)). First, we buffered the gnatcatcher location points and the modeled habitat by 1,000 meters, which encompassed most occurrences in our database. Where these buffered areas overlapped, we drew our range line; in areas where gaps in the buffered areas occurred, we used the 2,000-foot elevation line to complete the range line. Since a model for habitat suitability is not available for the portion of the range in Baja California, the eastern limit remains the same as presented in the 2016 finding and the southern limit has been adjusted farther north from 30°N to approximately 32°N latitude (Figure 8). Overall, the current range of the coastal California gnatcatcher extends across approximately 5 million ac (2,023,428 ha) (total land mass) from Ventura County, California in the United States south to just north of Ensenada, Baja California, Mexico. We estimate the quantity of CSS throughout the range is approximately 1.65 million ac (667,731 ha; 1,642,186 ac/664,569 ha in U.S. and 10,597 ac/4,288 ha in Mexico). In Southern California, most of the habitat within its range occurs on private land (see Appendix B for breakdown of land ownership). The updated range map is shown in Figure 9.

Figure 8. The Coastal California Gnatcatcher Southern Range Extent at Listing (30°N) and Currently (32°N).

Figure 9. The current range of the coastal California gnatcatcher. See text for delineation methodology.

CHAPTER 4 - RESOURCE NEEDS

The resource needs of the coastal California gnatcatcher are those factors needed for species viability. We assessed these resource needs first at the individual level, secondly at the population level and lastly at the species level. The needs for each level, when met, ensure persistence at that level and are cumulative across levels. For example, if an individual is unable to fulfill its individual needs, it will not survive, and thus will not contribute to the population. If all the individuals in a population are unable to fulfill their needs, that population will not persist; likewise, if a population is unable to fulfill its needs, that population will not persist, resulting in a loss to the resiliency of the species. On a large enough scale, the inability to fulfill individual-level or population-level needs can ultimately lead to species extinction.

4.1 INDIVIDUAL-LEVEL RESOURCE NEEDS

The individual-level needs of the coastal California gnatcatcher categorized by life stage are listed in Table 2, below. Starting at the egg stage, to develop properly, individual eggs need appropriate nutrients including fat, protein, water, and calcium, which are obtained from an adequate insect prey base ingested by an adult female prior to egg-laying. To hatch, gnatcatcher eggs require two adults for incubation and protection from the elements. To provide protection from nest depredation or brood parasitism, a nest placed in vegetation with sufficient cover is required. Therefore, during the egg life stage, individual needs include appropriate CSS habitat, foraging habitat that supports an adequate insect population, and adults for incubation.

Once hatched, coastal California gnatcatcher hatchlings require a nest placed in the appropriate vegetation, continual brooding from an adult to provide protection from the elements and body temperature regulation, and a diet of insects provided by an adult. Thus, individual gnatcatcher hatchlings require appropriate CSS habitat, foraging habitat that supports insect populations, and two adults, one of which to provide insects for feeding and the other for brooding.

As the hatchlings grow and develop feathers, becoming nestlings, they will become slightly less dependent on the adults but will still require protection and feeding. Thus, individual gnatcatcher nestlings require appropriate foraging habitat, insect prey base, adults to provide insects, and nesting vegetation.

As fledglings, individuals will begin to leave the nest but remain close to parents and nest-mates. The adults will continue to bring the fledglings food, but the fledglings begin learning how to forage soon after fledging and are able to acquire food for themselves at approximately 4 to 5 weeks of age. As they explore farther from the nest, appropriate sage scrub vegetation and non-CSS buffer habitat is important for cover and foraging. Thus, the needs at the fledgling stage include adults to provide food and supplementary feed, adequate insect prey base, appropriate sage scrub vegetation for foraging, and buffer habitat for foraging and protection.

At the juvenile life stage, the adults will chase the juvenile gnatcatcher out of their territory. To find their own territory, individual juveniles require adjoining suitable habitat or habitat corridors (e.g., CSS and non-CSS to support dispersal to adjoining suitable habitat). During dispersal and once settled into their new territory, juveniles require appropriate nutrients acquired from an adequate insect prey base for molting and survival, especially during winter when temperatures decline, and wet conditions make thermoregulation more difficult. Juveniles also need temperatures to be above about 2.5° Celsius (°C; 36.5° Fahrenheit (°F)), which during the winter, is not necessarily assured (Preston *et al.* 2008, p. 2512; Mock 1998, p. 418). Overall, juvenile gnatcatchers need habitat corridors for dispersal, foraging habitat that supports adequate insect prey, enough CSS habitat for territory establishment and to support eventual breeding.

As a breeding adult, gnatcatcher individuals need appropriate nesting vegetation for sheltering and nest placement and materials for nest building. Adults will glean insects from the leaves and stems of various plants, thus appropriate foraging habitat, which includes CSS and adjacent non-CSS, is necessary. Females may require more nutrients than males during egg formation (see above), which if they need to re-nest, which may occur multiple times over the course of the breeding season. Both male and female adults will need to acquire enough prey items to bring to hatchlings, nestlings, and fledglings. Therefore, an adequate insect population is necessary. After breeding, adults need adequate energy and nutrients to molt their feathers. In the winter, suitable temperatures above 2.5 °C (36.5 °F) are required for survival (Preston *et al.* 2008, p. 2512; Mock 1998, p. 418). Lastly, to successfully complete reproduction, adult gnatcatchers require other individuals of the opposite sex for mating. Thus, the needs of an adult gnatcatcher are appropriate CSS habitat, buffer habitat, nesting material, insect prey base, and a mate for reproduction.

4.2 POPULATION-LEVEL NEEDS

The abundance within a population is dependent upon the fecundity (birth rate), survival (death rate), and dispersal (immigration and emigration) rates. California gnatcatchers are persistent nesters and will re-nest after failure, leading to approximately 70 percent of gnatcatcher pairs successfully producing fledglings in a breeding season (Grishaver *et al.* 1998, p. 314). Survival and fecundity can vary substantially year to year, dependent on weather variation. Cold, wet winters typically decrease adult survival (Mock and Bolger 1992, p. A-29), although extended drought conditions reduce reproductive success by decreasing food abundance (Patten and Rotenberry 1999, entire; Bolger *et al.* 2005 cited in Vaughan 2010, p. 9).

For coastal California gnatcatcher populations to be resilient, they require enough individuals within connected habitat patches of adequate area and quality to maintain survival and reproduction despite population fluctuations associated with environmental stochasticity and disturbance. Resiliency relates positively to population size, growth rate, and connectivity among individuals. When a species is resilient, there exists sufficient suitable, occupied habitat to support large and stable enough populations such that the species can recover from periods of low abundance via population recruitment and/or recolonization of habitat vacated in response to stochastic events. Stochastic events that may affect the gnatcatcher and its habitat include wildland fire and weather anomalies. A variety of factors may influence gnatcatcher population levels that are density-dependent (e.g., habitat quality, habitat abundance) or density-independent (e.g., climate). The population-level needs considered for this SSA include dispersal, abundance, fecundity, and survival.

Table 2. Coastal California gnatcatcher individual resource needs and their function by life stage.[1]

Life Stage	Needs	Resource Function
Egg	Fat, protein, water, and calcium (insects) for formation (foraging habitat)	F
Egg	Adults for incubation	S
Egg	Nesting vegetation	S
Hatchling	Adults for continual brooding and feeding	F/S
Hatchling	Insect prey base for foraging adults	F
Hatchling	Protection from elements	S
Hatchling	Nesting vegetation	S
Nestling	Adults to provide food	F
Nestling	Insect prey base for foraging adults	F
Nestling	Protection from elements	S
Nestling	Nesting vegetation	S
Fledgling	Adults to provide food and demonstrate foraging	F
Fledgling	Insect prey base	F
Fledgling	Non-CSS buffer habitat	S
Juvenile	Insect prey base	F
Juvenile	Habitat corridors for dispersal	D
Juvenile	CSS habitat	F/S
Juvenile	Buffer habitat (non-CSS) adjacent to CSS	F/S/D
Adults	Insect prey base	F
Adults	CSS habitat	F/S/D
Adults	Buffer habitat (non-CSS) adjacent to CSS	F/S/D
Adults	Mate for reproducing	B
Adults	Nesting material	B

[1] The third column categorizes these needs on whether they function for breeding (B), feeding (F), Sheltering (S), or dispersal (D).

To maintain the resiliency of coastal California gnatcatcher populations, appropriate quantities of suitable CSS vegetation connected by habitat corridors for dispersal are necessary. A "core-and-linkage" network of habitat across the range helps ensure coastal California gnatcatcher connectivity and dispersal. The core areas are large, mostly unfragmented habitat areas in which the coastal California gnatcatcher lives and establishes territories. The larger a core area is, the greater the number of gnatcatchers it can support (i.e., the higher the quantity of suitable habitat present, the higher gnatcatcher abundance and occupancy will be). The linkage areas are intended to provide continuous or ''steppingstone'' corridors for coastal California gnatcatcher movement and dispersal. These linkages are important at all life stages but especially during the juvenile stage to facilitate natal dispersal and allow individuals to find their own territory. Dispersal between core areas reduces inbreeding, facilitates recolonization following local extirpation, and helps to maintain genetic diversity. The ability for individuals to move between populations promotes gene flow, which helps to maintain genetic variation (i.e., adaptive capacity) and geographic redundancy of the species. Dispersal ability and proximity to high-quality habitat is also important for maintaining individuals in habitat refugia that are capable of recolonizing recovering habitat following wildfire (Winchell and Doherty 2014, p. 543). Additionally, allelic richness is higher in areas where greater amounts of suitable habitat are present within the surrounding areas (see *Habitat Connectivity* section, below). Therefore, connectivity between habitats is important to maintain the population dynamics and genetic variability of the coastal California gnatcatcher subspecies.

4.3 SPECIES-LEVEL NEEDS

As a subspecies, the coastal California gnatcatcher needs multiple, resilient, connected populations with a high level of genetic diversity across a breadth of environmental conditions throughout its range. A matrix of large, unfragmented core areas connected by corridors of habitat throughout the range ensures gene flow and contributes to representation and redundancy. This is especially important following stochastic events such as large-scale wildfires. Recent genetic information on the coastal California gnatcatcher has indicated that the subspecies retains genetic connectivity across most of Southern California. Gnatcatchers rely on CSS habitat for survival and reproduction, but they can utilize areas of marginal habitat, such as riparian or weedy areas, for foraging and dispersal during the non-breeding season (Preston, Mock *et al.* 1998, p. 250) and as refugia following fire. To ensure viability, the subspecies needs to maintain its genetic representation and a distribution of resilient populations throughout its range to ensure redundancy.

4.4 UNCERTAINTIES

As discussed in the *Analysis of Demographic Factors* section, surveys for the coastal California gnatcatcher have focused on conserved and military lands and occurred periodically throughout portions of the subspecies' range. This makes it difficult to obtain accurate rangewide demographic information. The current survey and monitoring efforts provide us with presence or absence data, and occupancy rates across portions of the subspecies range but do not yet provide adequate information for inferring rangewide population trends. Additionally, there is a large disparity in the available information between the coastal California gnatcatcher's range in the United States and its range in Mexico. The dearth of gnatcatcher-specific information from Baja California combined with known differences in vegetation and climate makes it difficult for us to confidently assess the subspecies' status in the southern parts of its range; however, a qualitative assessment is provided.

4.5 EVALUATION OF RESOURCE NEEDS

For individual survival, coastal California gnatcatchers need appropriate nutrients and shelter for basic survival and reproduction to maintain resiliency at all life stages. To assure nutrient needs are met, an adequate and diverse insect prey base is required. Suitable CSS habitat provides shelter, locations for nest placement and egg hatching, and foraging habitat for individuals. Reproduction (fecundity) and survival allow populations to persist and promotes dispersal. Successful dispersal is important because it promotes immigration and emigration, which promotes gene flow and increases redundancy and representation; thereby helping the subspecies to better withstand catastrophic events and ensure its adaptive capacity. To assess these population needs, we will be evaluating the habitat suitability, habitat quantity, and habitat connectivity for each analysis unit. In contrast, the demographic factors of effective population size and occupancy will be assessed at the rangewide level.

Habitat Suitability

As discussed in the *Habitat* section above, coastal California gnatcatchers are an obligate species of CSS habitat. The availability of high-quality habitat is important to gnatcatchers for nesting, foraging, and sheltering, which is important for population resiliency, as areas in closer proximity to high-quality habitat are able to recolonize faster than areas where habitat quality is lower following a catastrophic event (Winchell and Doherty 2014, p. 543). In addition, the availability of suitable habitat has also been correlated with increased allelic richness (Vandergast *et al.* 2019, p. 6).

Habitat Quantity

In addition to the suitability of habitat, the quantity of suitable habitat is an important resource need for the coastal California gnatcatcher. Areas with a greater quantity of suitable habitat can support a higher abundance of individuals, contributing to increased resiliency. Greater habitat quantity also helps facilitate dispersal by providing linkages of habitat between core areas, supporting redundancy. Dispersal between locations promotes gene flow, thereby supporting representation.

Habitat Connectivity

Large areas of suitable habitat (i.e., core areas) are important to support an abundance of gnatcatcher individuals. Connectivity between core areas of suitable habitat throughout the range of the gnatcatcher allows gene flow through dispersing individuals and helps facilitate recolonization of core areas following local extirpation and allowing for multiple resilient populations. Additionally, areas with greater amounts of interconnected, highly suitable habitat exhibit higher allelic richness (i.e., adaptive capacity). Isolated populations are more susceptible to the effects of genetic drift and local extirpations. If areas of habitat are isolated from the rest of the range the risk of local extirpation is increased, and redundancy is decreased.

Effective Population Size

The viability of a population is strongly correlated with its effective population size, which provides a measure of the number of breeding individuals within a population. Populations with high effective population sizes exhibit higher genetic diversity (representation) and are less susceptible to the effects of genetic drift and inbreeding depression. In populations with low effective population sizes, the likelihood of mating among closely related individuals increases, resulting in a loss of genetic fitness from increased expression of deleterious recessive alleles. When combined with small population size, loss of fitness from inbreeding depression increases the risk of population extirpation by reducing reproduction and/or survivorship of individuals. At the species level, when populations become smaller and more isolated, depressed genetic variation reduces the evolutionary potential needed to help maintain resiliency of the species to changes in its environment. For this assessment, effective population size, although smaller than census populations, is being used a surrogate for abundance.

Occupancy

Populations need abundant individuals to persist and reproduce. Because it can be logistically difficult and expensive to track trends in abundance throughout the subspecies' range, habitat occupancy is a parameter that is correlated with abundance that is easier to measure and is being used to document patterns and trends in large-scale population dynamics. Increasing or stable occupancy rates can indicate that survival and reproduction within areas of occupied habitat are increasing or remain stable, and thus provide an indication of population resiliency. Analysis of habitat variables correlated with habitat occupancy and extinction and colonization events can provide insight into the habitat variables and resources important for maintaining gnatcatcher populations over the long term.

CHAPTER 5 - FACTORS INFLUENCING VIABILITY

In this chapter, we evaluate the past, current, and future influences that are affecting or could be affecting the current and future condition of the coastal California gnatcatcher throughout all or some of its range. Threats affecting the subspecies were analyzed by assessing the spatial extent within the context of the gnatcatchers range (scope), the intensity of the impact on the subspecies (magnitude), the probability that the threat will affect the subspecies in the foreseeable future (likelihood), and the time frame of the threat (immediacy). We summarize these influences in a conceptual model (Figure 10) and discuss in more detail below.

5.1 URBAN AND AGRICULTURAL DEVELOPMENT

The largest impacts to CSS in California, including within the range of the coastal California gnatcatcher, both past and present, have been from the effects of urbanization and agriculture (Cleland *et al.* 2016, p. 439). This has resulted in an estimated 85–90 percent reduction in the distribution of CSS, causing it to become one of the most endangered habitats in the United States at one time (Westman 1981, p. 182; O'Leary 1995, p. 28; Rubinoff 2001, p. 1375; Cleland *et al.* 2016, p. 430). Development for urban or agricultural use involves clearing of existing vegetation. Urban development not only results in buildings, roads, and other infrastructure, which are permanent, but also includes "temporary" impacts, such as pipeline installation or heavy equipment activity adjacent to permanent urban development (USFWS 2010, p. 12). While much of the urban development occurred in the past, there are still ongoing ramifications from those activities. Urbanized areas, especially densely urbanized areas, serve as barriers to gnatcatcher dispersal. For example, gnatcatchers in the northernmost portion of the range, specifically Ventura, Palos Verdes, Chino Hills, Coyote Hills, and San Joaquin Hills, exhibit significantly different allele frequencies (population differentiation) and lower allelic richness than gnatcatchers in other areas, indicating lower dispersal (Vandergast *et al.* 2019, p. 5–6). Further, when testing for geographic distances of first order relatives (full siblings or parents and offspring), three of the five locations (Ventura, Palos Verdes, Chino Hills) did not share relatives with any other area. This population structure and differentiation is likely due to higher levels of urbanization and lower amounts of suitable habitat that has reduced connectivity between these northern areas and the rest of the range, preventing dispersal.

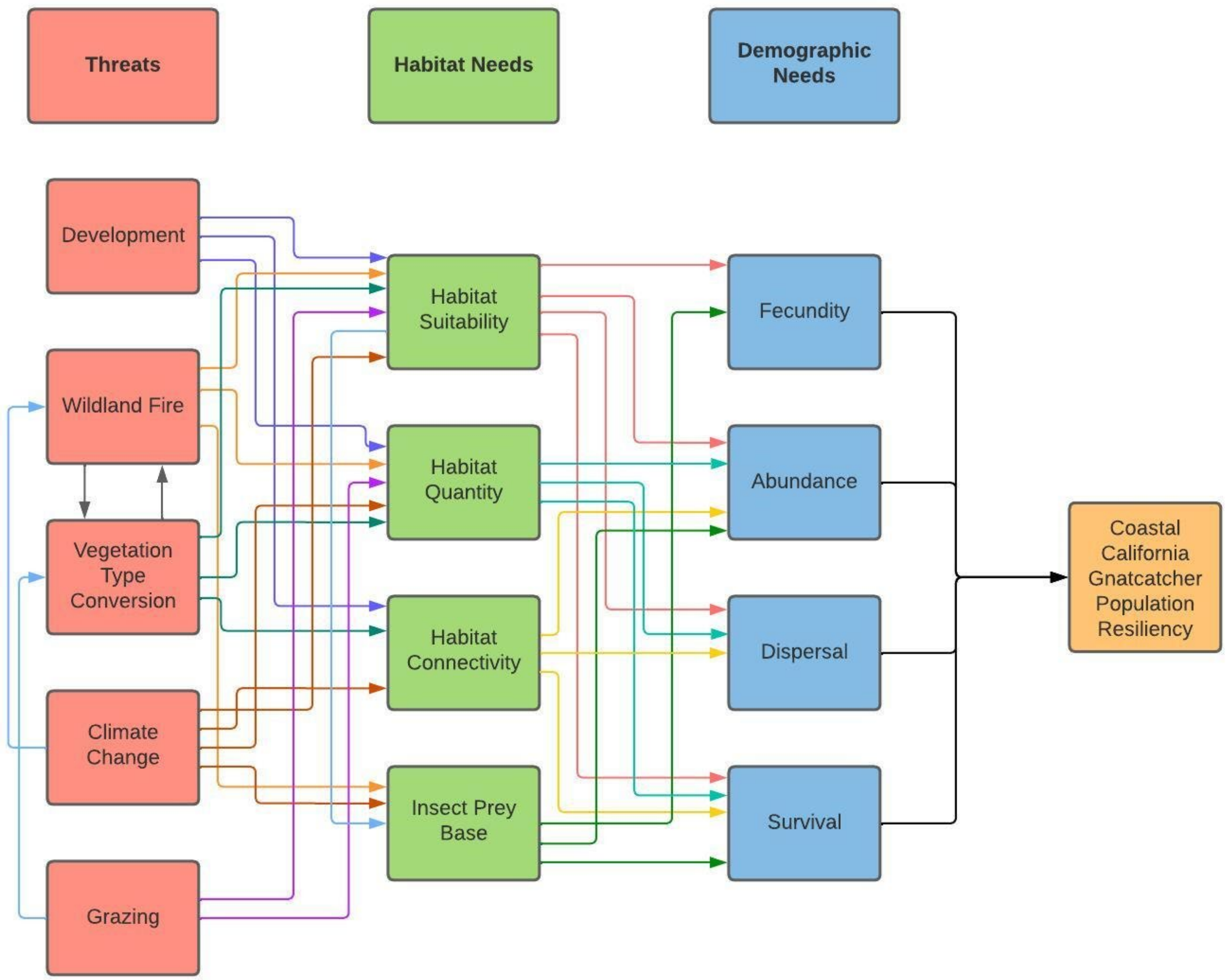

Figure 10. Conceptual model showing the interaction among threats and the habitat and demographic needs, and how they contribute to population resiliency for the coastal California gnatcatcher.

Agricultural development, although it does not result in the same level of infrastructure associated with urban development, involves the loss of habitat for the gnatcatcher from the replacement of sage scrub vegetation with intensively cultivated and irrigated crops. Areas of agriculture also likely serve as barriers to gnatcatcher dispersal, although there may be slightly higher permeability. At the time of listing, we identified urban and agricultural development as the primary cause of the loss of an estimated 58 to 61 percent of CSS in Southern California (USFWS 1993, p. 16746). Since then, urban development has continued to occur throughout the range of the coastal California gnatcatcher for which we concluded it remains an ongoing threat to the subspecies in our 2016 12-month finding (USFWS 2016a, pp. 59963–59965).

Currently, 44 percent of the subspecies' range in the United States, which includes CSS as well as other sensitive native habitat types and some partially developed areas, is included in subregional multi-species conservation plans/programs where the coastal California gnatcatcher is a covered species[2]. These conservation plans have served to direct development away from certain areas of coastal scrub vegetation and establish habitat reserves for the conservation benefit of the gnatcatcher and other species. By creating a network of managed preserves consisting of large core areas of higher-quality habitat connected by habitat linkages and corridors, these plans are contributing significantly to the conservation of the gnatcatcher. Continued implementation of existing HCPs and the ongoing development of other plans has significantly reduced the impacts of urban development throughout the U.S. portion of the coastal California gnatcatcher's range. Some actions being implemented in areas with HCPs include monitoring surveys, habitat enhancements, nonnative plant and animal control, and fire management. According to our analysis, 44 percent of the gnatcatcher range in Southern California is in permitted HCP/NCCP areas and 37 percent of modeled gnatcatcher habitat within Southern California is considered conserved (USFWS 2020, GIS Data). Completed and approved plans by subregion include:

1. Riverside County: Western Riverside Multiple Species Habitat Conservation Plan (MSHCP).

2. Los Angeles County: Rancho Palos Verdes NCCP/HCP.

3. Orange County: Central Coastal NCCP/HCP, Southern Subregion HCP, Orange County Transportation Authority NCCP/HCP, Shell/Metropolitan Water District HCP, Coyote Hills East HCP.

4. San Bernardino County: Wash Plan HCP.

5. San Diego County: Carlsbad Habitat Management Plan, San Diego South County MSCP (which includes 12 participating jurisdictions), San Diego Gas & Electric Subarea Plan, and San Diego County Water Authority NCCP/HCP.

The San Diego North County MSCP Plan is also within the range of the gnatcatcher and is still in development. Currently, there are no NCCP/HCPs in Ventura County, therefore, habitat in this portion of the range continues to be impacted by urban development at a higher rate than areas covered by regional planning efforts.

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[2] "covered" means that despite authorized habitat losses within the HCP Plan area, the USFWS has made a determination that adequate conservation has been provided in the plan area so as not to jeopardize survival and recovery of the species. In addition to regional conservation, there exists multiple individual and low-effect HCPs that provide conservation for the coastal California gnatcatcher.

The threats to the coastal California gnatcatcher associated with new urban and agricultural development in Southern California have subsided in recent years through implementation of regulatory mechanisms, especially the State of California's NCCP process and the Federal HCP process (USFWS 2010, p. 14). The rate of loss of coastal California gnatcatcher habitat due to agricultural development has also declined throughout Southern California. Historically, 1890–1930 was an intensive agricultural period in California with the expansion of dry land farming as well as rapid growth of intensively irrigated fruit and vegetable crops (Preston *et al.* 2012, p. 282). During this period, an unknown amount of CSS within Southern California was lost or modified. Post-World War II, the population boom then resulted in the conversion of many large agricultural areas to urban and suburban developments in Southern California (Preston *et al.* 2012 p. 282).

Using data from the Farmland Mapping and Monitoring Program (FMMP) of the Division of Land Resource Protection in the California Department of Conservation we evaluated land use changes in California since 1984 (California Department of Conservation 2018, data). Although not all areas of some counties have been inventoried, a review of data for Los Angeles, Orange, Riverside, San Diego, and Ventura counties indicates there has been a net loss of prime farmland from 1984 to 2018 of 147,030 ac (59,501 ha) (Table 3; California Department of Conservation 2018, data). Correspondingly, the reported net gains in urban and built-up land for the same time period and the same counties was 1,049,056 ac (424,538 ha) (Table 4; California Department of Conservation 2018, data). These numbers indicate that, although agricultural activities have declined in Southern California, former farmlands are most likely to transition to urbanized areas rather than reverting to or being restored to native habitat. As noted above, once areas are converted to agriculture or, especially, have become urbanized, they become permanent barriers to gnatcatcher dispersal, thereby negatively affecting gnatcatcher population connectivity and gene flow now and in the future.

Table 3. Change of acres classified as prime farmland used for agriculture between 1984 and 2018 (California Department of Conservation 2018, data).

County	1984	2018	Change
Los Angeles	40,059	22,238	–17,821
Orange	19,945	2,281	–17,664
Riverside	201,920	116,926	–84,994
San Diego	15,497	5,320	–10,177
Ventura	57,138	40,764	–16,374
Total	**33,559**	**187,529**	**–147,030**

Table 4. Change of acres classified as urban and built-up land between 1984 and 2018 (California Department of Conservation 2018, data).

County	1984	2018	Change
Los Angeles	122,481	788,355	+665,874
Orange	230,561	293,865	+63,304
Riverside	163,792	342,584	+178,792
San Diego	252,931	366,803	+113,872
Ventura	77,613	105,449	+27,836
Total	**847,378**	**1,897,056**	**+1,049,678**

Outside of the United States, conversion of habitat to urban development continues and is expected to continue into the future (Meyer *et al.* 2016, pp. 10, 13; Farewell 2019, pp. 46–47). While conservation of vegetation within the California floristic province of Baja California, Mexico, is receiving increasing attention (Meyer *et al.* 2016, p. 14), we are unaware of any conserved areas in the range of the coastal California gnatcatcher that contain much, if any, habitat suitable for the subspecies. No equivalent regulatory mechanisms to the NCCP/HCP process exist in Mexico. In Mexico, Federal, State, and local laws provide limited protections to coastal California gnatcatcher habitat (see *Regulatory Mechanisms in Mexico* discussion in Appendix A). Agricultural activity also continues to be a threat within the coastal California gnatcatchers range in Mexico where existing regulatory mechanisms allow land clearing for urban, agriculture and grazing practices to expand into sensitive habitats, particularly in northwestern Baja California (for example, Harper *et al.* 2011, pp. 28 and 31; Vanderplank *et al.* 2014, pp. 2175 and 2180–2181; Meyer *et al.* 2016, p. 10). These effects are likely to continue.

To summarize, urban development has been a historical and ongoing threat for the coastal California gnatcatcher. Although the implementation of HCP/NCCPs has significantly reduced the impacts of urban development in areas where regional conservation plans are in place, the total habitat protection that will be achieved in some of these areas (e.g., San Diego and Riverside Counites) has not yet been fully realized and will be incrementally configured over the term of plan implementation (e.g., 75 years) according to specified conservation criteria. Additionally, some of the plans (e.g., southern Orange County) do not include explicit provisions for addressing habitat losses and conserving habitat within portions of the subregional planning boundaries, so habitat losses from urban development within these portions of the plan areas remain unaddressed and rely on existing regulatory mechanisms (e.g., sections 7 and 10 of the Act) for impact minimization. Within the areas where conservation planning efforts are in process, but plans have yet to be adopted, it is likely that some areas of suitable habitat will fall outside of targeted conservation areas and will be subject to loss from development in the future. In portions of the subspecies' range where there are no active conservation planning efforts underway, such as within San Bernardino, Los Angeles and Ventura counties, suitable habitat that is not yet conserved will continue to be threatened by urban development and other stressors. Therefore, we consider urban development an ongoing, rangewide threat of moderate magnitude likely to continue into the foreseeable future; particularly in the northern portion of the subspecies range where habitat is projected to become more suitable with climate change.

In Mexico, the gnatcatcher remains largely unprotected. No regulatory mechanism equivalent to the NCCP/HCP process exists to protect the coastal California gnatcatcher outside of conserved areas so urban development continues to be a threat. Therefore, urban development continues to result in impacts to coastal California gnatcatcher and its habitat throughout its range in the United States and Mexico, representing a medium-level threat that has the potential to lead to loss of isolated patches of habitat and impact gnatcatchers at the population level. This threat is expected to continue into the future.

Impacts to the gnatcatcher related to agricultural development is low in the United States but continues to remain a threat to the subspecies in Mexico. Although the gnatcatcher is listed under Mexico's version of the Endangered Species Act (SEMARNAT 2010, entire), it is not clear from the available literature the extent to which threats are reduced through its implementation. Also, there are few areas designated as protected in Mexico, and because such designations may be placed over private lands without economic compensation to the landowners, there is little incentive to implement the desired protections (White *et al.* 2006, pp. 205–206). Thus, the available information, albeit limited, suggests that the gnatcatcher and its habitat are receiving few benefits from existing regulatory mechanisms in Baja California. Therefore, we consider the threat of agricultural development to be a low-level stressor in the U.S. portion of the range and a medium- to high-level stressor in Mexico, which we anticipate will continue into the future.

5.2 GRAZING

Grazing and browsing of cattle, sheep, and goats, as identified in the 1993 listing rule and the 2010 5-year review, has potential to destroy and modify gnatcatcher habitat by promoting vegetation type conversion through the reduction of shrub cover and introduction of nonnative annual grasses. Vegetation type conversion is the modification of one habitat type to another through the effects of one or more stressors working individually or in combination, resulting in the degradation or elimination of the original habitat type (see *Vegetation Type Conversion* section, below). As grazing occurs within gnatcatcher habitat, the vegetation on which the California gnatcatcher relies for feeding and sheltering is disturbed, reducing its quality and abundance. A reduction in the quality and quantity of habitat thus reduces the dispersal, abundance, and fecundity of the coastal California gnatcatcher.

In the United States portion of the gnatcatcher's range, land used for grazing has substantially reduced since 1984 (California Department of Conservation 2018, data); however, this does not necessarily apply to CSS habitat. According to the California Department of Conservation FMMP, a reduction in land used for grazing has occurred in all counties that overlap the range of the gnatcatcher with the exception of Los Angeles County, which showed an increase in land being used for grazing (+30,934 ac (12,518 ha); Table 5; California Department of Conservation 2018, data). The largest decrease since 1984 has occurred within San Diego County, where there is an estimated decrease of 33,079 ac (13,387 ha) in area that is grazed; followed by Riverside County (–32,075 ac (12,980 ha)); Ventura County (–15,065 ac (6,097 ha)); and Orange County

(–4,348 ac (1,760 ha); Table 5; California Department of Conservation 2018, data). However, it is important to note this program does not inventory all areas of these counties. Overall, we consider grazing to be a low-magnitude stressor within the U.S. portion of the gnatcatchers range that has temporary impacts to small amounts of habitat and individual gnatcatchers due to the decline in grazing activity and increased regulation of grazing by local jurisdictions (for instance, city ordinances).

In Mexico, the effects of grazing on coastal California gnatcatcher habitat are less concentrated than in the United States due to seasonal moving of livestock. However, grazing in coastal scrub habitat can still result in vegetation type conversion, and land clearing for grazing and agriculture is ongoing within northern Baja California (Meyer *et al.* 2016, p. 10). Further, we are unaware of any restrictions on grazing activities in Mexico, so the impact on gnatcatchers in Mexico has continued to some extent. Overall, we consider grazing a low magnitude stressor of moderate scope that temporarily affects large patches of habitat and gnatcatchers within the subspecies' range throughout Mexico.

Table 5. Acres of grazing land 1984–2018 (California Department of Conservation 2018, data).

County	1984	2018	Change
Los Angeles	229,763	260,697	+30,934
Orange	40,651	36,303	-4,348
Riverside	141,932	109,857	-32,075
San Diego	159,835	126,756	-33,079
Ventura	212,779	197,714	-15,065
Total	**784,960**	**731,327**	**-53,633**

5.3 WILDLAND FIRE

Wildland fire has the potential to cause both short term (displacement, temporary loss of habitat that supports breeding, feeding, and sheltering, direct mortality of eggs and nestlings) and long-term impacts to the gnatcatcher (permanent habitat loss). Long term impacts are associated with high fire frequencies that can lead to habitat degradation or loss from vegetation type conversion (see *Vegetation Type Conversion* section, below). Wildland fire is a natural ecological process that operates in habitat occupied by coastal California gnatcatchers. Coastal scrub plants have adapted to a natural fire regime through the ability to resprout from their crown post-fire and/or germinate from unburned seeds in the soil (Westman *et al.* 1981, pp. 170–171; Westman 1982, pp. 95–96; Malanson and O'Leary 1985, p. 357; Malanson and Westman 1985, p. 315; Keeley 2006, p. 364–365). Because CSS is adapted to fire, at low fire frequencies (and without type conversion) impacts to gnatcatcher populations can be expected to eventually recover, depending on the time it takes for the vegetation community to recover from fire. Data suggests that the length of this temporal impact is longer in dryer inland areas where it takes longer for the vegetation community to return to its pre-fire composition and structure (Westman *et al.* 1981, pp. 169–171; Kus et al. 2024, p. 28).

Habitat loss due to fire creates corresponding impacts to gnatcatchers at the population and individual level. Fires in CSS can degrade or destroy gnatcatcher habitat, by destroying all or most of the aboveground portion of plants. The reduction in the quality and quantity of CSS habitat from fire, in turn, reduces the dispersal, fecundity, and occupancy of gnatcatcher populations. Individually, adult gnatcatchers are likely to survive the direct effects of fire by dispersing; however, mortality may result to eggs, nestlings, and young fledglings if the fire occurs during the nesting season (van Mantgem *et al.* 2015, p. 136; LSA Associates 1994, p. 36).

The scope and severity of a fire determines how impactful it will be to gnatcatchers at the population level. If a fire covers a large enough area, the elimination of entire territories of multiple individual gnatcatchers occurs, resulting in displacement to adjacent habitat areas (Atwood, Bontrager, and Gorospe 1998, pp. 409, 411). Observations of gnatcatchers following fire have shown that, over the short term, the severity of fire affects gnatcatcher occupancy (LSA Associates 1994, p. 36; Leatherman Bioconsulting, Inc. 2012, p. 5). For example, following the Windy Ridge and Santiago fires in 2007, large losses of CSS habitat led to reductions in the habitat occupancy rates of the California gnatcatcher throughout the Central Reserve in Orange County. Four years post-fire, a study on the status of gnatcatchers within the Central and Coastal Reserves in Orange County showed that no gnatcatchers occurred (zero occupancy) within severely burned plots, as compared to 8.9 percent occupancy in moderately burned plots, and 23 percent occupancy in lightly burned plots (Leatherman Bioconsulting, Inc. 2012, p. 5). Of all the surveyed plots within burned areas, only 10.1 percent (7 of 65 plots) showed gnatcatcher occupancy (Leatherman Bioconsulting, Inc. 2012, pp. I, 5). In another analysis of the data, gnatcatcher occupancy was estimated to be 6 percent (CI: 2–16 percent) in burned areas and 35 percent (CI: 26–) outside of burned areas four years post fire (2011) (Miller, W. B. 2023, pers. comm.). USGS, in partnership with the San Diego Management and Monitoring Program (SDMMP), is conducting additional research to gain a better understanding of the effects of wildland fire on coastal California gnatcatcher occupancy within coastal scrub vegetation in Southern California (Kus et al. 2024, entire). Initial results are showing that within 5-10 years gnatcatcher occupancy rebounds to within about 50–66 percent of unburned habitat occupancy (i.e., no fire since 2002). Subsequent post fire recovery progresses much more slowly, such that areas that burned 10+ years ago still have occupancy half that of unburned sites, suggesting it in some cases may take decades without fire for complete population recovery, depending on precipitation patterns and vegetation type conversion rates (Kus 2020, SDMMP Annual Monitoring and Management Meeting, Kus et al. 2024, p. 28). In addition to the size and severity of a fire, the quality of habitat before the fire may also play a role in how quickly gnatcatcher occupancy rebounds. According to Winchell and Doherty (2014, p. 543), depending on the habitat quality within and surrounding the burned area, it may take 5 or more years for gnatcatcher populations to recolonize the burned habitat but to reach pre-burn levels likely takes many more years. Higher quality habitat adjacent to burned areas are likely to support higher densities of gnatcatchers capable of recolonizing, and higher quality burned habitat is also more likely to be recolonized as the vegetation recovers (Winchell and Doherty 2014, p. 543).

Fire frequency is another factor to consider concerning the effects of fire on coastal California gnatcatchers. The historical fire return interval for CSS ecosystems was about once every 30 to 40 years, but fire frequencies have increased dramatically as human populations have increased

(Keeley and Fotheringham 2001, pp. 1542–1543; Conlisk *et al.* 2015, p. 28). While also dependent on the surrounding land uses and vegetation type (i.e., the flammability of surrounding vegetation) human population density is correlated with an increase in fire ignitions and number of fires (Keeley and Fotheringham 2001, pp. 1542–1543; Fusco *et al.* 2016). The greater number of fires, many of which have burned large areas of CSS, has resulted in more areas of young growth coastal scrub vegetation that does not provide equal habitat suitability for coastal California gnatcatchers. Increased fire frequency not only decreases the habitat quality of CSS for gnatcatchers over the decades it takes for the habitat to recover, but it can also result in permanent loss and degradation of large areas of CSS habitat through vegetation type conversion (see *Vegetation Type Conversion* section, below). As mentioned above, CSS is adapted to a natural fire return interval of about once every 30 to 40 years. Our spatial data show that approximately 43 percent of modeled habitat in Southern California (308,029 acres (124,654 ha)) has burned two or more times in the past 40 years (USFWS 2022, GIS data; Figure 12).

The scope, intensity, and frequency of wildfire is influenced by climate change as well as other factors such as temperature, precipitation, wind, population, and development (Bedsworth *et al.* 2018, p. 28). As a result, predicting where and how fires will burn is difficult; however, climate projections for California predict an increase in wildfire risk. In Southern California, longer periods of drought and decreased precipitation combined with dry and hot Santa Ana winds are likely to create ideal fire conditions for longer periods throughout the year—essentially extending the fire season (Jennings *et al.* 2018, p. 16). Furthermore, as the climate continues to warm, precipitation is projected to become more volatile (less frequent and more extreme), consequently increasing vegetation dieback and increasing fire risk (Jennings *et al.* 2018, p. 16; Goss *et al.* 2020, pp. 11–12). In addition to the biophysical factors that influence fire risk, anthropogenic factors such as ignitions, development at the wildland-urban interface, and infrastructure contribute to wildfire risk (Bedsworth *et al.* 2018, p. 28; Goss *et al.* 2020, p. 11). Like Southern California, northern Baja California is a Mediterranean-type ecosystem and is projected to experience hotter and drier conditions with more seasonally extreme rainfall as climate change continues (Arias *et al.* 2021, p. 140; Jennings *et al.* 2018, p. 17). Extended periods of drought and increased aridity of vegetation will increase fire risk throughout the entire range of the coastal California gnatcatcher.

Using fire data from our GIS files (USFWS 2022) and the habitat suitability model from USGS (Preston *et al.* 2020), we estimate that 146,421 ac (59,254 ha), or 10.5 percent, of modeled gnatcatcher habitat in Southern California burned from 2016–2020. During the 5-year period before that (2011–2015), we estimated that 52,311 ac (21,170 ha) of modeled gnatcatcher habitat burned. The 10 years combined totaled 198,732 ac (80,423 ha), or 14.1 percent (Figure 11). When comparing acres of modeled gnatcatcher habitat burned over the last 20 years (going back from the most recent year we have data, 2001–2020, inclusive), to the 20-year period before that (1981–2000), 2.8 times more acres of modeled habitat burned from 2001 to 2020 than from 1981 to 2000 (191,200 ac (77,375 ha) from 1981 to 2000, compared to 532,072 ac (215,321 ha) from 2001 to 2020; Figure 12). In total, 38.2 percent of modeled gnatcatcher habitat has burned at least once in the past 20 years, compared to 13.7 percent in the two decades before that (USFWS 2022). While much of that habitat has likely recovered, data suggests that it could take decades for gnatcatchers to return fully to pre-burn densities, as discussed above, and occupancy remains lower in burned areas relative to unburned areas after decades (Kus et al. 2024, p. 27). Lastly, if those areas have burned again without recovering (increased fire frequency), gnatcatcher occupancy may still be depressed.

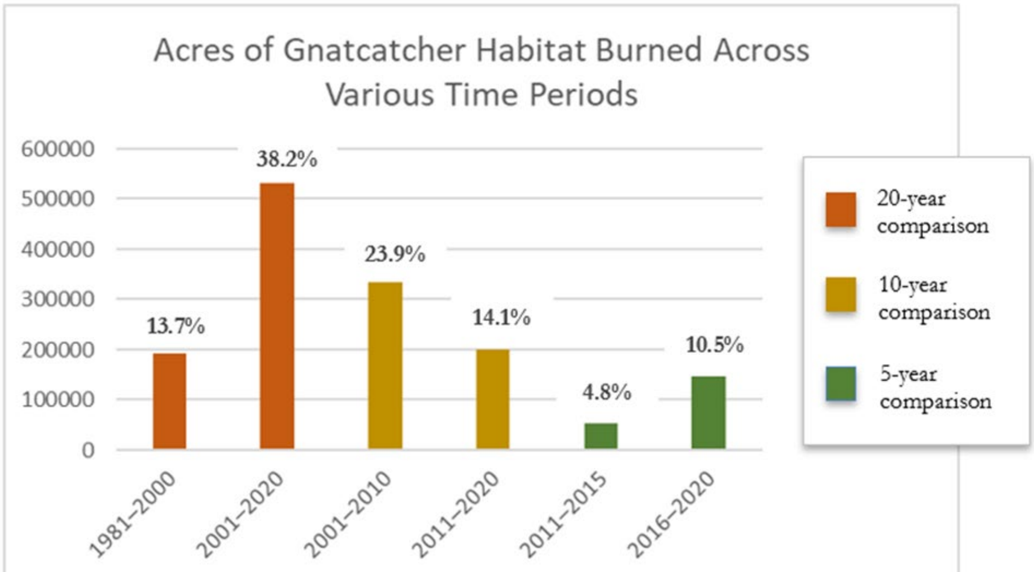

Figure 11. 20-year, 10-year, and 5-year comparison of burned modeled gnatcatcher habitat. Percentages at top of bars represent the percent of total modeled gnatcatcher habitat that burned in each period.

Overall, wildland fire remains an ongoing rangewide threat to the coastal California gnatcatcher that can have effects at the individual and population level. The predicted increase in fire severity and frequency is likely to reduce the availability and quality of gnatcatcher habitat, resulting in the loss of individual gnatcatchers and a reduction in gnatcatcher occupancy of burned areas for years or even decades. Although currently established NCCP/HCPs provide for the establishment of CSS reserves and include fire management as one of their primary objectives, there is no mechanism or conservation measure currently in place that can fully prevent the recurrence of natural or human-caused wildland fires in coastal California gnatcatcher habitat. Lastly, it likely takes decades or longer for habitat to recover and gnatcatchers to return to pre-burn occupancy densities in areas that have undergone severe fire. Thus, fire reduces the carrying capacity for gnatcatchers within the habitat that has burned thereby lowering the overall resiliency of gnatcatchers within the available habitat. Therefore, we consider wildland fire to represent a high-magnitude threat that is likely to continue into the future throughout the gnatcatchers range. Large-scale wildland fire followed by vegetation type conversion represents the most significant catastrophic threat to the coastal California gnatcatcher and its habitat.

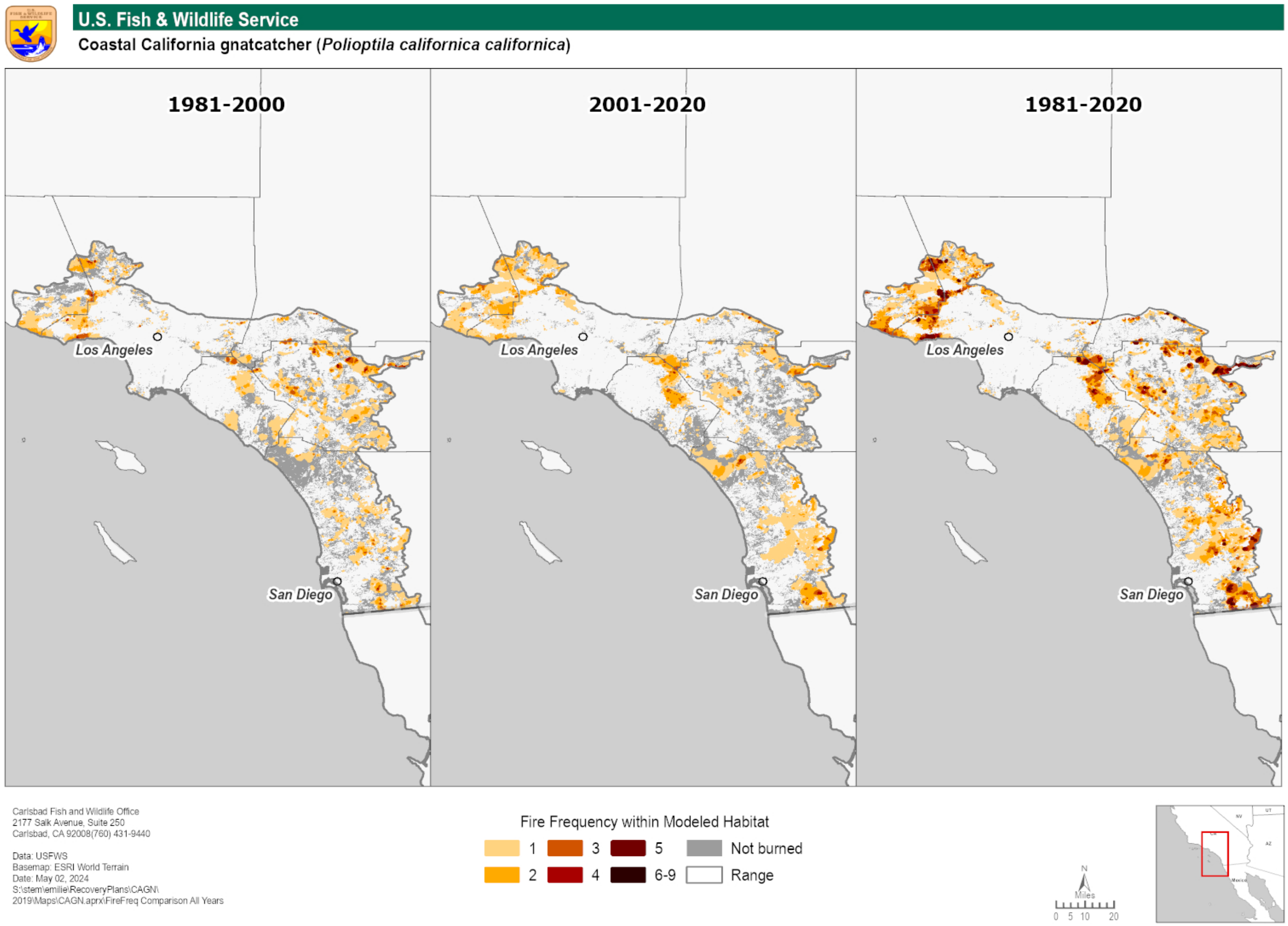

Figure 12. Fire frequency (number of times burned) and area burned within coastal California gnatcatcher modeled habitat 1981–2000, 2001–2020, and 1981–2020. From 1981 to 2000, 191,200 ac (77,375 ha; or 13.6 percent) of modeled habitat burned compared to 532,072 ac (215,321 ha; 37.8 percent) from 2001 to 2020. From 1981 to 2020, 308,029 acres (124,654 ha, or 43 percent) of modeled habitat burned.

5.4 VEGETATION TYPE CONVERSION

Vegetation type conversion (or simply, type conversion) is the process by which one habitat type changes to another. Type conversion of gnatcatcher habitat has been occurring for many years and typically involves the transition of native coastal scrub to nonnative annual grasslands. The introduction of nonnative plant species, in combination with one or more stressors, such as physical disturbance (for example, clearing by heavy machinery), livestock activity, wildland fire, and anthropogenic atmospheric pollutants (particularly nitrogen compounds) are drivers that can influence type conversion of sage scrub habitat. Depending on the influencing factors, this conversion can occur over various temporal and spatial scales.

Invasive, nonnative plant species are widely established in the coastal scrub communities of Southern California and northern Baja California, Mexico. Throughout the range of the gnatcatcher, activities that create severe physical disturbance to CSS have facilitated the introduction of many nonnative invasive plant species—particularly historical grazing. While the presence of nonnative species in itself does not cause coastal scrub to convert, other stressors in combination with nonnative plant introductions promote type conversion by giving nonnative plant species a competitive advantage (Keeley *et al.* 2011, p. 203; Conlisk *et al.* 2015, p. 28). In particular, the nonnative annual plant–wildland fire feedback loop is associated with conversion of CSS to grassland (Zedler *et al.* 1983, pp. 817; Keeley *et al.* 2005, p. 2123; Talluto and Suding 2008, p. 804; Fleming *et al.* 2009, p. 2223; Conlisk *et al.* 2015, p. 28). Nonnatives are typically short-lived annuals; after dying, the nonnatives dry and create a layer of detritus that readily ignites and carries fire (Minnich and Franco-Vizcaíno 2005, p. 381; Lambert *et al.* 2010, p. 31). Nonnative plants also tend to dry out earlier in the spring than native species, promoting earlier fires, in essence, extending the fire season (i.e., shorter fire intervals; Keeley *et al.* 2005, p. 2123; Lambert *et al.* 2010, p. 31). Additionally, the proximity of coastal scrub habitat to human activity, specifically roads and utilities, has increased anthropogenic ignitions, further contributing to increased fire throughout the subspecies' range (see *Wildland Fire* section, above). The increased fire frequency not only causes physical disturbance, it leaves little time for native coastal scrub—which is adapted to longer fire intervals—to recover between fires, whereas annual grasses quickly regrow after fires; this creates a positive feedback loop further promoting CSS type conversion to grassland (Lambert *et al.* 2010, p. 31, Kus et al. 2024, p. 14). Throughout San Diego and Orange Counties, non-native grass and other herbaceous vegetation have increased in areas with fire history and slowed the reestablishment of shrub cover (Kus et al. 2024, p. 27). Increased non-native and herbaceous vegetation cover not only contributes to conditions that increase fire frequency, but it also reduces habitat suitability for gnatcatchers, resulting in lower occupancy of previously burned areas (Kus et al. 2024, p. 2). Severe weather may also play a role in fire frequency, such as extensive drought and high temperatures, which is projected to occur more frequently as global climate change occurs (see *Climate Change* section, below). Although it is difficult to predict how natural communities will respond, increased drought and temperatures may continue to promote increased wildfire and continued coastal scrub degradation (Kimball *et al.* 2014, 1391). Overall, the introduction of nonnative plant species, in combination with elevated fire frequency, creates a positive feedback loop that ultimately leads to the modification and eventual loss of CSS habitat throughout the range of the gnatcatcher.

Atmospheric pollutants, especially nitrogen-based compounds, can also contribute to the degradation of coastal scrub vegetation by facilitating the invasion of nonnative annual grasses. The input of these fertilizer-like compounds (soil nitrification) places native coastal scrub at a competitive disadvantage by potentially shifting the mycorrhizal communities from one of benefit to native species to one that favors nonnative grasses (Egerton-Warburton and Allen 2000, p. 494; Sigüenza *et al.* 2006, p. 22; Kimball *et al.* 2014, p. 1400). This competitive disadvantage that favors nonnatives, in combination with fire or other physical disturbance, helps to facilitate the invasion of nonnative grasses and displacement of native shrubs (O'Leary and Westman 1988, p. 784; Talluto and Suding 2008, p. 813; Kimball *et al.* 2014, p. 1401). Atmospheric pollutants affect coastal scrub areas over large portions of the range of the gnatcatcher, especially areas downwind of urban centers or large agricultural areas (Fenn *et al.* 2003, p. 404–405). The effects of atmospheric pollutants are particularly heightened within the Los Angeles basin and Riverside areas, which frequently experience weather conditions that results in a warm air layer that sits atop cooler air at ground level (i.e., inversion layer). The inversion layer acts like a lid, trapping the layer of cooler air and any pollutants at ground level. As the air sits trapped, pollutant levels can build up over time and concentrate to high levels, resulting in increased risk of CSS degradation.

In all, the presence of invasive, nonnative plants, in combination with one or more stressors, causes the ecological balance to shift away from native plants towards nonnative plants, resulting in degradation and, ultimately, type conversion of gnatcatcher habitat. Depending on the stressors, such degradation occurs over various temporal and spatial scales. In particular, the nonnative annual plant–wildland fire feedback loop can cause large areas of habitat to type convert over a short period while atmospheric pollutants affect even larger areas, but over longer periods. The conversion of CSS habitat to nonnative grassland leads to a reduction in the quality, quantity, connectivity, and density of suitable gnatcatcher habitat throughout the subspecies' range, thus limiting the dispersal ability, abundance, and fecundity of the gnatcatcher.

To maintain habitat quality, the degradation and loss of sage scrub vegetation from nonnative plant invasions and type conversion due to high fire frequencies must be controlled by reducing the frequency of fire ignitions or active management. The NCCP/HCP plans that are in place include some measures for managing coastal scrub vegetation, such as implementation of invasive species and fire management plans, that may help to reduce the effects of type-conversion throughout the range of the coastal California gnatcatcher in the United States (USFWS 2016a, p. 59966). However, to date, these programs have not attempted to manage nonnative annual grasses which have become a naturalized component of most vegetation communities, and for which it is likely infeasible to manage at a landscape scale. While a goal of the fire management plans is to help manage the frequency of fire ignitions within the habitat reserves, these planning efforts have been more successful at managing fuel loading and maintaining defensible space at the Wildland Urban Interface than reducing the frequency of fire ignitions. Fire frequencies and extent of habitat burned on an annual basis have continued to increase despite the implementation of these plans. In addition, long-term management plans are not yet complete for all the preserve areas and ensuring there are sufficient resources for perpetual management of the reserves that addresses existing and future stressors poses a challenge common to all regional NCCP/HCPs. These circumstances suggest it is uncertain whether long-term management will be able to adequately address vegetation type conversion in the future.

Vegetation type conversion represents a high-magnitude threat affecting the habitat of the coastal California gnatcatcher throughout its range. Vegetation type conversion can cause long-term habitat alterations across large habitat areas, impacting the gnatcatcher at the population level. While some conservation mechanisms are in place to help reduce this threat in some areas in the United. States, the available information suggests they do not fully address the wide range of pervasive stressors, particularly the synergistic effects of the nonnative annual plant–wildland fire feedback loop. The best available scientific and commercial information indicates that vegetation type conversion will continue to have long-term impacts throughout the range of the gnatcatcher into the future.

5.5 CLIMATE CHANGE

Global scale climate projections are informative, and, in some cases, the best scientific information available for some geographical locations. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (e.g., IPCC 2013, entire; IPCC 2014, entire). Therefore, we use "downscaled" projections when they are available to provide higher resolution information that is more relevant to the spatial scales used for analyses of a given species (for additional information on downscaling, see Glick *et al.* 2011, pp. 58–61; Pierce *et al.* 2014, entire; Behnke *et al.* 2016, entire).

Various changes in climate may have direct or indirect effects on a species. These may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as interactions of the climate with other variables such as habitat fragmentation (for examples, see Franco *et al.* 2006; Forister *et al.* 2010; Galbraith *et al.* 2010; Chen *et al.* 2011, entire). In addition to considering individual species, scientists are evaluating potential climate change-related impacts to, and responses of, ecological systems, habitat conditions, and groups of species (see, for example, Deutsch *et al.* 2008; Berg *et al.* 2010; Euskirchen *et al.* 2009; McKechnie and Wolf 2010; Sinervo *et al.* 2010; Beaumont *et al.* 2011; McKelvey *et al.* 2011; Rogers and Schindler 2011; Bellard *et al.* 2012).

Temperature

Regional temperature observations are often used as an indicator of how the climate is changing, and according to the Fourth California Climate Change Assessment, temperatures throughout the State have increased over the past century (Bedsworth *et al.* 2018, p. 22). Present day temperatures (1986–2016) have exceeded 0.5°C;(1°F), and even exceed 1.1°C (2°F) in some areas, above recorded temperatures from 1901–1960 (Bedsworth *et al.* 2018, pp. 22–23). At the regional level, temperature records from 1896–2015 for the California South Coast Climate Division, which encompasses the U.S. range of the gnatcatcher, had the most consistent and significant warming trends at annual, seasonal, and monthly scales (He and Gautam 2016, p. 15). Three indicators of temperature, the increase in mean temperature, the increase in maximum temperature, and the increase in minimum temperature illustrate trends in climate change in California. In the South Coast Region, every month has experienced a significantly positive trend in the monthly average, minimum, and maximum temperatures over the past century (Hall *et al.* 2018, p. 9). Additionally, the top 5 warmest years of recorded annual average temperatures have occurred since 2012, where 2014 was the warmest year, followed by 2015, 2017, 2016, and 2018 (NOAA National Centers for Environmental Information 2022, p. 2).

While these observed temperature trends provide information about how climate has changed in the past, we must also consider how climate may change in the future. Climate models can be used to simulate and develop future climate projections. California's Fourth Climate Change Assessment presented both statewide and regional probabilistic estimates of temperature and precipitation changes for California anticipated under a range of potential atmospheric greenhouse gas concentration scenarios (Representative Concentration Pathways, "RCP") using data from 10 global climate models (GCMs) most representative of California. The output from these models was then downscaled using the Localized Constructed Analogs (LOCA) statistical downscaling method (Pierce *et al.* 2014, 2018 entire).

Regional temperature projections from California's Fourth Climate Change Assessment indicate that temperatures in both the Los Angeles and San Diego regions, which encompass the U.S. range of coastal California gnatcatcher, are expected to increase in the coming decades (Hall *et al.* 2018, pp. 9–12; Kalansky *et al.* 2018, pp. 19–23). By the end of the century (2100) in San Diego County, yearly average temperatures are projected to rise by about 2.2–3.3 °C (4–6 °F) under the RCP 4.5 scenario (i.e., assuming moderation of current anthropogenic greenhouse gas emissions) or 3.6–5 °C (7–9 °F) under RCP 8.5 (i.e., unmoderated "business as usual" greenhouse gas emissions) (Figure 13; Kalansky *et al.* 2018, p. 19). In Los Angeles County, temperatures are projected to rise from the historical annual average maximum temperature of 22.5 °C (72.5 °F) to about 25.4 °C (77.8 °F) by the end of the century under the RCP 4.5 scenario or 27.2 °C (80.9°F) under RCP 8.5 (Figure 14; Hall *et al.* 2018, p. 10).

Precipitation

Modeled projections of precipitation changes, which are more complex than temperature projections, do not indicate extreme deviations from historical averages but rather changes in the seasonal pattern of precipitation (Pierce *et al.* 2018, p. 20; Jennings *et al.* 2018, pp. 3–14). The simulated projections indicate spring rains ending sooner and fall rains starting later, leading to more prolonged and extreme seasonal summer drought in the future (Jennings *et al.* 2018, p. 13; Kalansky *et al.* 2018, p. 24). Under the RCP 8.5 projections, spring precipitation decreases approximately 20 percent by midcentury, and 25 percent by the end of the century. In the fall, these projections indicate decreases of approximately 15 percent midcentury, and approximately 20 percent by the end of the century (Jennings *et al.* 2018, p. 13). Under RCP 4.5, the occurrence of dry years is also projected to increase, though not to the same degree and not as often as in the RCP 8.5 (Figure 15). The projected increased periods of drought and longer seasonal dryness will be countered by an increase in the wettest days (greater precipitation variability). By 2100, the wettest day of the year is projected to increase 15 to 25 percent under RCP 4.5 projections and increase 20 to 30 percent under RCP 8.5 (Jennings *et al.* 2018, p. 14).

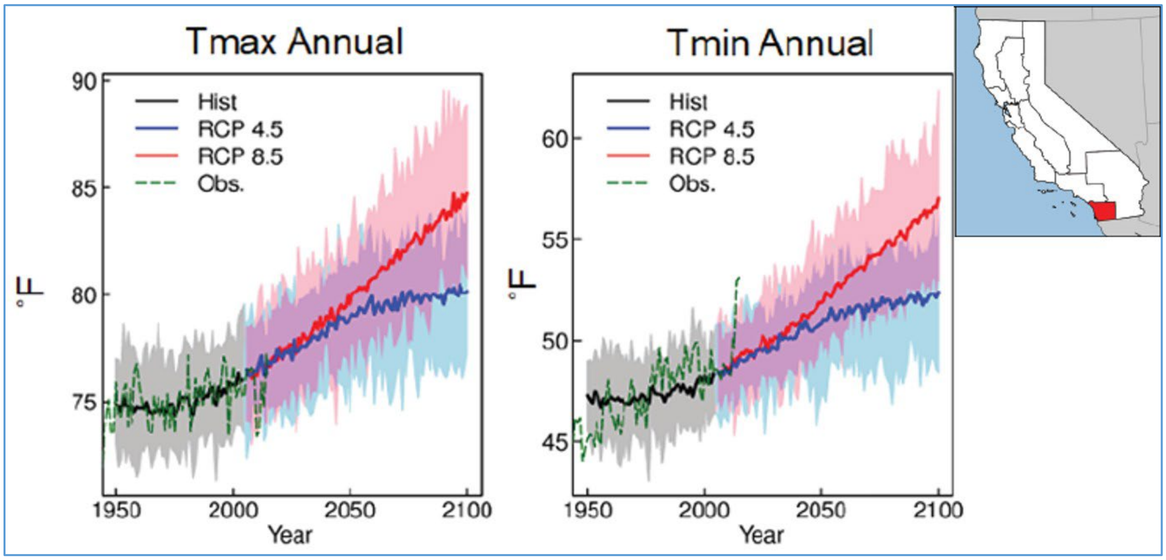

Figure 13. The annual average increase in maximum (Tmax) and minimum temperatures (Tmin) averaged over San Diego County from Localized Constructed Analogues (Pierce *et al.* 2014; Pierce *et al.* 2018). The shading shows the range of models under historical (black), RCP 4.5 (blue) and RCP 8.5 (red) and the line shows the ensemble mean. The historical observations in the green dashed line are based on the Livneh *et al.* (2015) gridded data. (Graphic and caption source: Kalansky *et al.* 2018, p. 19 (State of California, public domain)).

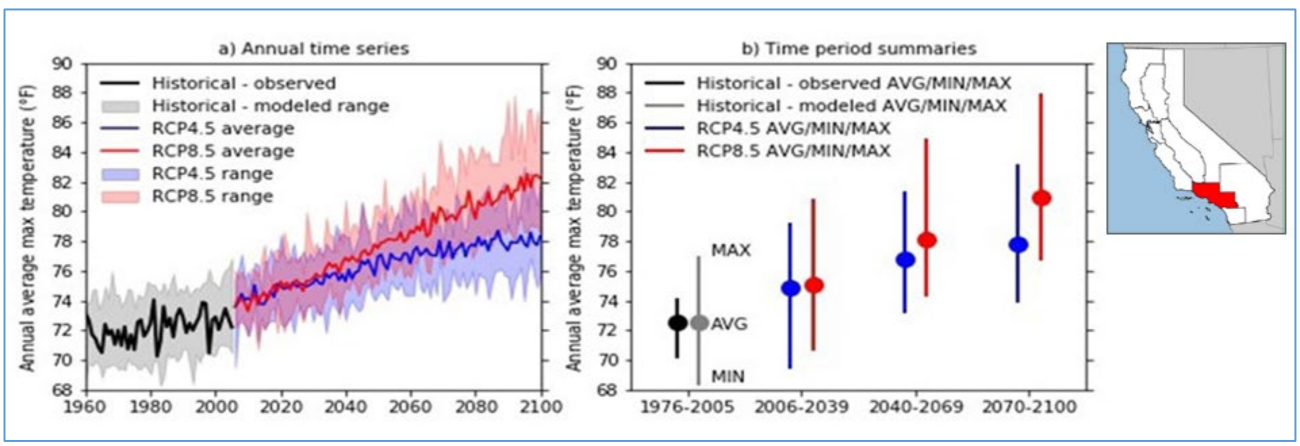

Figure 14. Historical-observed (black), historical-modeled (grey), and projected future (RCP4.5 - blue, RCP8.5 - red) annual average maximum temperature over the LA region. (a) Annual time series of data (future projections begin in 2006), with solid lines representing model-averages and shading representing model spread. (b) Summary of model-average (circles) and spread (vertical lines) across four time periods: 1976-2005 (historical), 2006-2039 (early-21st century), 2040-2069 (mid-21st century), and 2070-2100 (late-21st century). Unit is °F. (Graphic and caption source: Hall *et al.* 2018, p. 10 (State of California, public domain)).

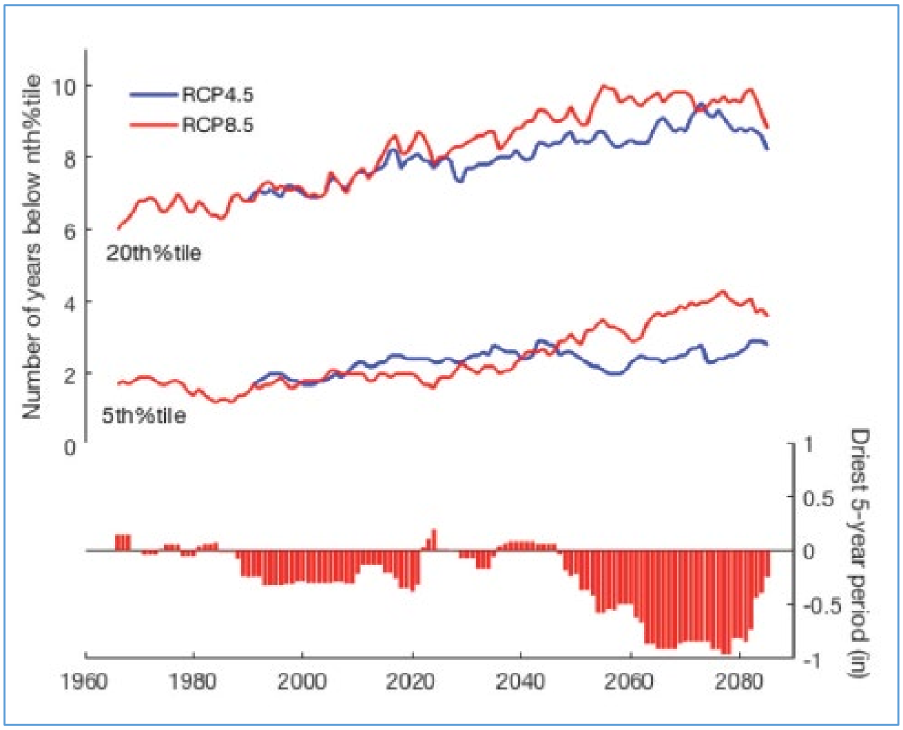

Figure 15. (Top) The percent of years in a 31-year sliding window that are below the 20th and 5th percentile thresholds averaged from a set of 10 RCP 4.5 (blue) and 10 RCP 8.5 (red) climate change simulations. (Bottom) Departure from average of the driest 5-years in a 31-year sliding window for RCP 8.5 (right). The anomaly is based on the average driest 5-years within the historical period. (Graphic and caption text source: Jennings *et al.* 2018, p. 38 (State of California, public domain)).

In addition to changes in seasonal precipitation patterns, annual variability in precipitation is projected to increase as a result of wetter days when precipitation occurs, but with fewer days of precipitation (Pierce *et al.* 2018, p. 20). The decrease in the number of days with precipitation indicates that droughts are projected to become more frequent and intense, especially under RCP 8.5 projections (Figure 15; Jennings *et al.* 2018, p. 12).

Climate Change and the Coastal California Gnatcatcher

We expect the potential changes in climate described above to have some effect on the coastal California gnatcatcher and its habitat. While the physical and biological mechanisms that result in the establishment of coastal scrub or chaparral vegetation are unclear, minimum temperatures, maximum temperatures, and precipitation (both amount and seasonality) throughout the range of the coastal California gnatcatcher represent important influences on the subspecies and its habitat (Franklin 1998, p. 745). As noted above, it is highly likely that minimum and maximum temperatures will continue to rise. Malanson and O'Leary (1995, p. 219) suggested that higher average temperatures in the future may create an upslope shift in coastal scrub vegetation into areas that are currently occupied by chaparral. This may expand or shift areas that currently provide suitable habitat for coastal California gnatcatchers. Similarly, because the subspecies' distribution is thought to be limited by low temperatures (Mock 1998, p. 415), warmer minimum temperatures may also allow for coastal California gnatcatchers to survive at higher elevations and farther north, thereby allowing the subspecies to extend its range into areas previously not occupied (Preston *et al.* 2008, p. 2,512). Using distribution models incorporated with biotic interactions, Preston *et al.* (2008, entire) predicted future suitable habitat conditions for the coastal California gnatcatcher under various temperature and precipitation climate conditions to determine the subspecies sensitivity to climate change. Overall, they predict an eastern and upslope shift of habitat into areas currently too seasonally cold to support gnatcatchers and an overall reduction in habitat availability under most modeled climate conditions, with a particular sensitivity to precipitation increases (Preston *et al.* 2008, pp. 2508–2512). However, it is important to note that these models did not consider habitat loss from urban and agricultural development or vegetation type conversion so there could be less available habitat than suggested under their predictions (Preston *et al.* 2008, p. 2510). In addition, some of the areas predicted to be suitable for coastal California gnatcatchers in the future are presently occupied by the closely related black-tailed gnatcatcher; therefore, it is difficult to predict whether the coastal California gnatcatcher will be able to successfully disperse into these areas or if their dispersal will be restricted due to competitive exclusion (Preston *et al.* 2008, p. 2512).

In contrast, increased frequency and intensity of droughts in combination with higher temperatures will lead to moisture loss from the land surface, increasing susceptibility to fire and further promoting an increased wildland fire frequency (Jennings *et al.* 2018, p. 12). These changes have the potential to create large-scale effects on ecological community composition by promoting conditions more favorable for vegetation type conversion to nonnative annual grassland, which would be unsuitable habitat for coastal California gnatcatchers (Jennings *et al.* 2018, p. 12) (see *Vegetation Type Conversion* and *Wildfire* sections, above). Additionally, increased drought has a negative effect on terrestrial arthropod populations, the coastal California gnatcatcher's food source. A study on the effects of drought on the wrentit (*Chamaea fasciata*), spotted towhee (*Pipilo maculatus*), California towhee (*Melozone crissalis*), and rufous-crowned sparrow (*Aimophila ruficeps*)—all species that can co-occur with gnatcatchers in CSS habitat—found significant decreases in their reproductive success attributed to reduced arthropod food availability during drought (Jennings *et al.* 2018, p. 13; Bolger *et al.* 2005, pp. 402–403). Thus, reduced reproductive success and impaired population recruitment may be other possible responses to increased drought events.

Overall, the effects of climate change represent a low- to moderate-level stressor across the range of the coastal California gnatcatcher. Changes in temperature and precipitation may cause an upslope shift of CSS habitat, potentially expanding the preferred habitat of the coastal California gnatcatcher. On the other hand, these changes also promote conditions favorable for conversion of suitable gnatcatcher habitat to annual grassland through increased drought, and fire frequency and intensity. These effects are reliably predicted to have population-level effects on the coastal California gnatcatcher into the 2060s.

5.6 DISEASE

We have previously identified West Nile virus and Newcastle disease as potential threats to the coastal California gnatcatcher (USFWS 2010, p.22). While detections of West Nile virus have occurred within the geographic range of the gnatcatcher, we are not aware of any evidence indicating the virus has caused any decline in gnatcatcher populations. Additionally, we are unaware of any incidence of Newcastle disease within the subspecies' range. In 2022, an outbreak of highly pathogenic avian influenza (HPAI), or bird flu, was first detected in birds within the United States (CDC 2022, web). Avian influenza viruses occur naturally in wild aquatic birds and are very contagious among birds, especially poultry species. Thus far, passerine species do not seem susceptible to HPAI and no detections have been observed in the gnatcatcher (CDC 2022, web; Bunting *et al.* 2023, web; CDC 2023, web). As a result, we do not consider HPAI a current threat to the subspecies. In conclusion, just about every organism is affected by disease to some extent under normal and natural conditions; we are not aware of any diseases that are currently affecting coastal California gnatcatchers at the population level, nor do we anticipate any in the future. Therefore, we do not consider impacts of disease a current threat to the gnatcatcher.

5.7 PREDATION

Predation occurs at all life stages of the coastal California gnatcatcher to varying degrees but only nest predation has been identified as affecting recruitment and survival at levels that could have potential effects on the population. Nest predation is the most common cause of nest failure and impacts individuals at the egg, hatchling, and nestling life stages when a predator kills or consumes them. Various studies have reported nest predation of California gnatcatchers to occur at rates ranging from 26 to 68 percent (USFWS 2010, p. 23; Atwood and Bontrager 2020, unpaginated). Population-level effects of nest predation reduce recruitment by lowering fledgling success resulting in lower resiliency.

Gnatcatchers occupy a naturally predator-rich environment, and potential predators include various species of reptiles, birds, and mammals (Atwood 1990, pp. 18–19; Bontrager 1991, p. 16; Braden and Powell 1994, pp. 17–18; Galvin 1998, p. 326). While direct observations of nest predation are rare, researchers have particularly identified the California scrub-jay (*Aphelocoma californica*), greater roadrunner (*Geococcyx californianus*) and various species of snakes as known predators of gnatcatchers and other nesting birds in sage scrub vegetation communities (Atwood 1990, pp. 18–19; Braden *et al.* 1997, p. 864; Bontrager 1991, p. 16; Braden and Powell 1994, pp. 17–18; Galvin 1998, p. 326). Additionally, the invasive Argentine ant (*Linepithema humile*) has been observed infesting gnatcatcher nests, resulting in the abandonment of nests and death of nestlings (Sockman 1997, p. 327; Atwood and Bontrager 2020, unpaginated). In addition to causing direct mortality of chicks, researchers have suggested that Argentine ants may indirectly impact bird species by reducing arthropod prey and negatively affecting reproductive success in areas where Argentine ants have been introduced, although more research into this potential relationship is needed (Suarez *et al.* 2005, p.381, Nell et al. 2023 p.14). It is unclear whether the effects from the invasive Argentine ants are greater than impacts from native ant species (Suarez *et al.* 2005, p.381).

Nest predation rates are difficult to link directly to the status of a species due to other natural and anthropogenic events and processes that affect the species at the same time. This is especially true for the gnatcatcher, which occupies a naturally predator-rich environment and subjects the subspecies to a higher nest predation rate than most other open-nesting passerines (Braden 1999,

p. 991; USFWS 2010, p. 23). In response to the high rate of nest predation, the gnatcatcher has adopted a life-history strategy that involves repeated re-nesting in the case of nest failure, compensating for this potential stressor. Therefore, predation undoubtedly has individual-level effects, but is not currently believed to have a population-level impact.

5.8 BROOD PARASITISM

Brown-headed cowbirds (*Molothrus ater*) are obligate brood parasites; that is, they do not raise their own young but instead get other species of birds (the *hosts*) to do it for them by laying their eggs in the other species' nests (Gill 1995, pp. 459–466). Brown-headed cowbirds are host generalists (Friedmann and Kiff 1985, p. 227), which means they parasitize the nests of a wide range of host species. Some potential host taxa reject the cowbird egg by removing the foreign egg, abandoning the parasitized nest, or through some other method; other host taxa generally accept the foreign egg and raise the cowbird chick as if it were its own (Rothstein 1975, pp. 253–254). Brown-headed cowbirds parasitize coastal California gnatcatcher nests to various degrees throughout the subspecies' range, depending upon nearby land uses, with higher rates of brood parasitism occurring near agriculture or livestock (Braden 1992, pp. 14–15; Atwood and Bontrager 2020, unpaginated). Although native to North America, it is unclear whether or to what geographical extent brown-headed cowbirds occurred west of the California Peninsular Ranges prior to European colonization; if cowbirds occurred at all, the available literature suggests they were not numerous (Rothstein *et al.* 1980, p. 256; Laymon 1987, entire; Fleischer and Rothstein 1988, p. 1147). Expanding from the east, the brown-headed cowbird range had extended into Southern California by 1920 (Laymon 1987, entire). Because brown-headed cowbirds are not native to the range of the coastal California gnatcatcher, any rate of brood parasitism is higher than historical rates. Brown-headed cowbirds continue to be common throughout most of Southern California and Baja California (Unitt 2004, p. 569; Erickson *et al.* 2013, p. 601). Gnatcatchers abandon parasitized nests at higher rates than non-parasitized nests, and gnatcatchers that accept the cowbird egg typically fail to fledge their own or cowbird young (Braden *et al.* 1997, p. 861). When gnatcatchers accept the cowbird's eggs, the cowbird hatchlings invariably out-compete their nest-mates for food brought by parents.

Management of cowbird populations by trapping has also been effective at reducing impacts of brood parasitism (USFWS 2010, p. 33). In one study, cowbirds parasitized up to 32 percent of gnatcatcher nests in years that cowbird trapping was not occurring (Braden *et al.* 1997, p. 861). In areas with active ongoing cowbird trapping, monitoring programs observed marked increases in the reproductive success of the gnatcatcher (Bontrager *et al.* 1995, p. 23; Griffith and Griffith 2000, p. 349–351). Additionally, cowbird trapping enacted within neighboring riparian habitats, primarily for least Bell's vireo (*Vireo bellii pusillus*), has spillover benefits for the gnatcatcher, despite occurring in habitats not frequented by gnatcatchers (Griffith and Griffith 2000, p. 351). The plans developed under section 10 of the Act and the State's NCCP law incorporate implementation of adaptive management programs as part of the conservation strategy, which includes the potential to perform cowbird trapping programs should it be determined that such programs are needed to help conserve covered species. However, to date, most of these plans are not implementing cowbird trapping programs. Most cowbird control is being implemented as a conservation measure associated with Federal consultations for individual projects under section 7 of the Act.

The effects of brown-headed cowbirds on populations of gnatcatchers in Mexico is unknown, but cowbirds occur along the Baja California peninsula (Erikson *et al.* 2007, p. 583). It is likely the impacts on the Mexican gnatcatcher subpopulation are like portions of the United States range where cowbird management does not occur.

Overall, brood parasitism from brown-headed cowbirds remains a threat to the gnatcatcher to varying degrees within the subspecies range. However, gnatcatchers have the ability to double clutch during the reproductive season to compensate for nest failure, which is estimated to be three times as likely from predation (Braden et al., 1997, p. 863). Thus, as with predation, brood parasitism does not appear to be having a population-level effect at this time, though more study on nest parasitism rates is needed. Overall, brood parasitism from cowbirds is a low -magnitude threat having effects at the individual level in localized areas throughout the range and is not currently influencing the subspecies' resiliency.

5.9 FRAGMENTATION

Fragmentation occurs when a large, continuous block of habitat is broken up into smaller areas, resulting in small remnants of native vegetation surrounded by a mosaic of other habitat types, agricultural, or developed land. In this way, fragmentation remains inextricably linked with habitat destruction and type conversion (see *Urban and Agricultural Development* and *Vegetation type conversion* sections, above). The physical changes in the environment caused by fragmentation have effects not only on the biogeography of an area (distribution of species and ecosystems in an area) but on individual species as well. Depending on the habitat remnant and the sensitivities of the species, the consequences of these effects may include increased predation rates, genetic isolation, or increased risk of extirpation. The size of the remnant (area and edge effects), distance and degree of connectivity between other remnants, and the time since the remnant was isolated all play into how a species responds to fragmentation (Saunders *et al.* 1991, p. 22).

The coastal California gnatcatcher does not appear to be particularly sensitive to edge effects (changes in population or community structure at the boundary of two or more habitats) but rather to the effects of habitat degradation, which may be more concentrated at habitat edges (Bolger 2002, p. 149; Kristan *et al.* 2003, p. 42). Habitat at fragment edges tends to be more susceptible to nonnative invasion due to increased soil disturbance, promoting further degradation and decreasing the area of quality habitat, especially in smaller fragments (smaller edge to area ratio; Saunders *et al.* 1991, pp. 24–25). Whether area size has an influence on occupancy rates of the gnatcatcher has been up for some debate. Previous studies have shown that gnatcatchers generally occupy and are more persistent in larger habitat areas (Soulé *et al.* 1988, pp. 82–83; Atwood, Tsai *et al.* 1998, 347–348; Bolger 2002, pp. 144–145; Crooks *et al.* 2004, p. 454–456; Sartain and Alberts 2008, p. 88). However, a large regional survey detected gnatcatchers in small habitat patches (e.g., ≤ 10 hectares in coastal areas) and showed little support for a strong relationship between patch size and occupancy (Winchell and Doherty 2008,

p. 1326). Following adoption of a subregional habitat conservation plan in Orange County, the program to monitor gnatcatchers in the Habitat Reserve was initially stratified to contrast the density of gnatcatcher territories in "core" (at least 1,000 ac. of contiguous habitat), "fragment" (less than 1,000 ac. of contiguous habitat in size) and "edge" (within 984 feet of development) areas (Hamilton 2004, pp. 3–4). This program found gnatcatchers at much higher densities within edge and fragment areas relative to the core areas of the Habitat Reserve. Possible explanations offered for this pattern included: lower relative habitat suitability for gnatcatchers in the core areas due to the high proportion of steep, high elevation, hard chaparral conserved in the core; recent large conflagrations that burned over 50 percent of the habitat within the reserve, driving surviving gnatcatchers to outlying habitat refugia; and the design of the Habitat Reserve to protect high target bird species densities that were naturally concentrated in lower elevation, less steep, edge and fragment areas vegetated with coastal sage scrub (Hamilton 2004, p. 44).

Distance effects do not appear to have as large of an effect on gnatcatchers as previously believed, and urban dispersal appears to be occurring among gnatcatchers (Bailey and Mock 1998, p. 359). In addition, recent genetic analysis has revealed genetic signatures indicating a high level of connectivity and gene flow throughout most of Southern California (Vandergast *et al.* 2019, p. 5). Exceptions to this are the northernmost populations in Ventura County, on the Palos Verdes Peninsula, and in the Coyote Hills (Vandergast *et al.* 2019, pp. 5–6) where habitat isolation is associated with reduced gene flow. Large distances between these subpopulations within which there is a low proportion of adjoining suitable habitat appears to separate these areas from the rest of the population in Southern California. Overall, the gnatcatcher remains largely connected throughout Southern California but emergent genetic structure among the northern areas suggests the gnatcatcher is likely to be sensitive to further increases in fragmentation and isolation of habitat within the northern portion of its range. In Baja California, genetic analysis of individuals throughout the peninsula revealed an admixture among the three subspecies residing there, indicating a high level of connectivity (Vandergast *et al.* 2022, pp. 1210–1211). A significant genetic break occurs between birds sampled north and south of the 32°N latitude line (Vandergast *et al.* 2022, pp. 1210–1211). This is likely at least partially due to the extensive urbanization in the Tijuana region restricting gnatcatcher movement.

Ongoing and anticipated implementation of regional NCCP/HCPs works to create a network of core-and-linkage habitat areas, thereby preventing or reducing the effects of future habitat fragmentation for much of the coastal California gnatcatcher range in Southern California. The core areas are large, mostly un-fragmented areas, while conserved habitat linkage areas are intended to provide continuous or ''stepping-stone'' corridors for coastal California gnatcatcher movement and dispersal. Thus, the ability of the coastal California gnatcatcher to move between and recolonize habitat areas within Southern California, including the existing preserve-and-linkage areas, helps to reduce some of the effects associated with habitat fragmentation, although connectivity appears to be somewhat limited within the larger Los Angeles metropolitan area outside the boundaries of the adopted subregional multi-species conservation plans. This indicates that fragmentation at the rangewide scale is currently a threat of lower magnitude than initially believed at listing; however, fragmentation remains a significant threat in portions of the range that have become widely separated and geographically isolated (for example, populations in Ventura County, on the Palos Verdes Peninsula, and in the Coyote Hills in northern Orange County).

Summary of Threats

In our analysis, we examined the past, present, and foreseeable future threats affecting the condition of the coastal California gnatcatcher. We assessed the threats of urban and agricultural development, grazing, wildland fire, vegetation type conversion, climate change, disease, predation, fragmentation, and brood parasitism. Grazing, disease, predation, and brood parasitism are having local, small-scale impacts to the gnatcatcher; therefore, we do not consider them to be major threats now or in the foreseeable future. Fragmentation—once considered a higher-level threat—is now considered to be a lower magnitude threat than initially believed at listing, particularly in the southern portion of the subspecies U.S. range where NCCP/HCPs have provided for conservation in a “core and linkage” configuration. However, fragmentation remains a higher-level threat in the northern, isolated portions of the range where largescale conservation is not occurring, and data indicates there has been a loss of genetic connectivity with birds to the south. Agricultural development represents a low-level threat to the species in the United States but remains a medium- to high-level threat in Mexico. The implementation of NCCP/HCPs have significantly reduced the impacts of urban development in areas where these plans have been implemented, however, not all areas of suitable habitat fall within the targeted conservation areas. Furthermore, large portions of the range have no active conservation planning underway, leaving those areas vulnerable to habitat loss from development. In Mexico, no regulatory mechanism exists to protect the gnatcatcher outside of conserved areas. Therefore, though substantial progress has been made since the time of listing to conserve habitat that supports the gnatcatcher, we find that urban development continues to pose a threat to the coastal California gnatcatcher and its habitat throughout its range.

Wildland fire has been and remains an ongoing threat to the gnatcatcher and its habitat. Over the past 40 years, 43 percent of suitable gnatcatcher habitat has burned at least once and future projections predict a continuation to an increase in future fire risk. By consuming vegetation that is needed to support the feeding, breeding, and sheltering activities of gnatcatchers, fire temporarily reduces the carrying capacity of habitat capable of supporting gnatcatchers while the vegetation recovers, with studies suggesting it may take decades for gnatcatcher habitat occupancy rates to recover to pre-fire levels. Documented increases in fire frequency are also increasing the risk of vegetation type conversion. In combination, cumulative impacts from wildland fire and subsequent vegetation type conversion creates a positive feedback loop that promotes the degradation and eventual loss of CSS habitat. Additionally, the impacts of climate change are projected to promote an increase in fire frequency and intensity—further promoting the wildland fire-vegetation type conversion feedback loop. Therefore, wildland fire and vegetation type conversion remain a high-level threat throughout the range of the subspecies. In addition to promoting the conditions that promote increased fire, anticipated effects of climate change also include increased drought, greater precipitation volatility, and increasing temperatures. These effects may have impacts on food availability (decreased arthropod abundance during drought), gnatcatcher reproduction and survivorship, and a shift in CSS presence eastward and upslope. Whether a shift in CSS habitat because of climate change would expand the range of suitable habitat conditions for the gnatcatcher remains to be seen as potential competitive exclusion, or other biotic interactions, may prevent the gnatcatcher from dispersing to these areas. Therefore, we concluded that climate change is a low to moderate magnitude threat acting on the subspecies. The threat impact, scope, future direction and overall impact of assessed threats is summarized in Table 6.

Table 6. Summary of threat impact, scope, future direction and overall impact of the threats affecting the coastal California gnatcatcher.

Threat	Threat Impacts	Scope	Direction of Threat into Future	Overall Impact
Urban and Agricultural Development	Habitat	Rangewide	Ongoing	Moderate
Grazing	Habitat	Local	Decrease	Low
Wildland Fire	Habitat	Rangewide	Increase	High
Vegetation Type Conversion	Habitat	Rangewide	Increase	High
Climate Change	Habitat	Rangewide	Increase	Low to Moderate
Disease	Individuals	Rangewide	Minimal	Low to None
Predation	Individuals	Rangewide	Increase	Low to Moderate
Brood Parasitism	Individuals	Local	Minimal	Low
Fragmentation	Habitat	Local	Ongoing	Low to Moderate

CHAPTER 6 - CURRENT CONDITIONS

In this chapter, we describe the current condition of the gnatcatcher's habitat and demographic needs and the probable explanation for past and ongoing changes in abundance and distribution. For each analysis unit we describe the habitat condition categories, the amount of habitat considered conserved[3], and provide a breakdown of the land ownership to help provide an overview of the gnatcatchers' viability in each analysis unit. We are using analysis units to evaluate condition of habitat throughout the range. The demographic factors of effective population size and occupancy are discussed at the rangewide scale since recent genetic information suggests the subspecies is a single genetic unit throughout most of its range.

[3] For the purposes of this assessment, considered conserved means lands that are protected, managed, or unlikely to be developed. We included Federal lands in this definition.

Population resiliency for the gnatcatcher is then discussed based on the condition of the habitat factors across analysis units in combination with demographic factors analyzed at a rangewide scale. As discussed previously, we define viability as the ability of the gnatcatcher to sustain populations throughout its range over time. Using the SSA framework, we characterize the viability of the gnatcatcher in terms of its resiliency, redundancy, and representation (the 3Rs).

6.1 CURRENT CONDITIONS SUMMARY OF METHODS

To assess the current condition of the coastal California gnatcatcher, we identified habitat and demographic factors that influence population resiliency. Based on the availability of these needs, we defined habitat and demographic conditions for high, moderate, or low (Table 7, Table 8). For our analysis of habitat conditions, we divided the subspecies' range into six analysis units based on a combination of public land management boundaries and biological information (Figure 16). To get an overall rangewide assessment of habitat conditions, we averaged the scores of each analysis unit. Data for demographic factors were only available at the rangewide scale, so we did not use analysis units and instead assessed demographic condition at the population scale. The rangewide habitat and demographic condition scores together represent subspecies resiliency. Due to lack of information, the Baja California, Mexico analysis unit was assessed in a qualitative manner and is not comparable to the units in the United States. Additionally, we assessed the magnitude of each threat at the analysis unit level, which is summarized in Table 9 following the *Geographic Breakdown of Analysis Units* section.

The condition categories used to analyze the current condition of the gnatcatcher's habitat needs include habitat suitability, habitat quantity, and connectivity. A rating of high, moderate, or low condition was defined for each condition category and each analysis unit was assessed on that scale (Table 7). To estimate the overall rangewide habitat condition, all analysis unit scores were averaged. Effective population size and occupancy were used to evaluate demographic needs at the population scale. We are unable to assess the demographic factors at the analysis unit level, so we defined conditions for high, moderate, and low and assessed them at the rangewide scale (Table 8). A high condition indicates that there is a high probability of individuals persisting within the analysis unit; a moderate condition indicates the probability of persistence in that analysis unit may be compromised by the lack of one or more needs; and a low condition indicates that there is a low probability of individuals persisting in that analysis unit. A condition that is between, for example low/moderate or moderate/high, indicates a probability of extirpation between those two conditions. Population resiliency was described at the rangewide scale using rankings for overall habitat and demographic condition.

Table 7. Coastal California gnatcatcher condition category table of habitat needs. See text for details.

Condition	Habitat Suitability	Habitat Quantity	Connectivity
High – an indicator of high probability of persistence of individuals in the unit	**More than 50% of modeled habitat is rated greater than or equal to 0.5** by the USGS HSI model	Moderate- and high/very high-quality habitat is **greater than 150,000 acres**	Average percentage of habitat within 30 km throughout unit is **10% or greater**
Moderate – an indicator that probability of persistence in the unit may be compromised by the lack of one or more need	**30–50% of modeled habitat is rated greater than or equal to 0.5** by the USGS HSI model	Moderate- and high/very high-quality habitat is **75,000–150,000 acres**	Average percentage of habitat within 30 km throughout unit is **5–10%**
Low – indicates a low probability of persistence of individuals in the Unit.	**Less than 30% of modeled habitat is rated greater than or equal to 0.5** by the USGS HSI model	Moderate- and high/very high-quality habitat is **less than 75,000 acres**	Average percentage of habitat within 30 km throughout unit is **less than 5%**

Table 8. Coastal California gnatcatcher condition category table of demographic needs. See text for details.

Condition	Effective Population Size	Occupancy
High – an indicator of high probability of persistence of individuals	**Above N_e = 1,000** required to retain long-term genetic diversity	Occupancy is increasing
Moderate – an indicator that probability of persistence may be compromised by the lack of one or more need	**N_e = 100–1,000** needed to avoid short-term inbreeding depression, but below Ne needed to avoid long-term changes in genetic diversity	Occupancy is stable
Low – indicates a low probability of persistence of individuals	**Below N_e = 100** needed to avoid short-term inbreeding depression	Occupancy is decreasing

Figure 16. Coastal California gnatcatcher analysis units for the Species Status Assessment.

Table 9. Magnitude of threats impacting the coastal California gnatcatcher in each analysis unit.

Analysis Unit	Urban and Agricultural Development	Grazing	Wildland Fire	Vegetation Type Conversion	Climate Change	Disease	Predation	Brood Parasitism	Fragmentation
NAU	High	Low	High	High	Low to Moderate	Low	Low	Low	Moderate to High
NCAU	Low	Low	Low to Moderate	Moderate	Low to Moderate	Low	Low	Low	High
MCAU	Moderate	Low	High	Moderate to High	Low to Moderate	Low	Low	Low	Low
MIAU	Moderate	Low	High	High	Low to Moderate	Low	Low	Low	Low to Moderate
SAU	Low to Moderate	Low	High	Moderate to High	Low to Moderate	Low	Low	Low	Low
BCAU	Moderate to High	Low	Moderate to High	Moderate to High	Low to Moderate	Low	Low	Low	Low
Overall Magnitude of Threat	**Moderate**	**Low**	**High**	**High**	**Low to Moderate**	**Low**	**Low**	**Low**	**Low**

Geographic Breakdown of Analysis Units

Recent genetic analysis of coastal California gnatcatcher throughout Southern California has revealed a single genetic unit encompassing most of the range. To help evaluate population resiliency, we used several factors to compare habitat and demographic resources in each unit. To delineate the analysis units, we used a combination of biotic and abiotic factors. First, we recognized the distinction between the northern, more isolated portions of the range and behavioral distinctions between interior and coastal gnatcatchers. Secondly, we considered jurisdictional boundaries such as county lines and HCP areas, and barriers such as freeways to separate areas where management and/or level of threats may differ. This allowed us to divide the range into six units: the Northern Analysis Unit (NAU), the Northern Coastal Analysis Unit (NCAU), the Middle Coastal Analysis Unit (MCAU), the Middle Interior Analysis Unit (MIAU), the Southern Analysis Unit (SAU) and the Baja California Analysis Unit (BCAU) (Figure 16). The magnitude of each threat affecting the gnatcatcher was assessed based on scope, impact, and future direction for each analysis unit in Table 9.

Habitat Suitability

To calculate the condition of habitat suitability for each analysis unit, we used the habitat similarity index (HSI) model created by USGS (Preston *et al.* 2020, entire) to determine the acres and quality of the modeled habitat within each unit. To develop the model, USGS used Geographic Information Systems (GIS) software and calculated environmental variables at each point in a grid of points spaced 150 m apart. Environmental variables considered in the habitat similarity model include elevation, slope, northness, eastness, topographic heterogeneity (ruggedness), temperature (January minimum, July maximum), precipitation, and vegetation classification; developed areas were excluded (Vandergast *et al.* 2019, supplementary table S5). Using gnatcatcher observation records, they then performed an analysis to create continuous HSI scale ranging from 0 (unsuitable) to 1 (highly suitable)(for more details on the HSI model see Preston *et al.* 2020, entire; also see Vandergast *et al.* 2019, p. 9). To define habitat suitability for our analysis, we used a HSI threshold of 0.5 to identify high and very high suitable habitat as defined in Vandergast *et al.* (2019, p. 9). To define high, moderate, and low conditions we used the quantity of high and very high suitable habitat within the analysis unit. A high condition was given if 50 percent or more of the total modeled habitat within the unit was rated as 0.5 and above, a moderate condition was given if 30 to 50 percent of the total modeled habitat was rated as 0.5 and above, and a low condition was given if the unit contained less than 30 percent of habitat rated as 0.5 or higher. Percentages were calculated by dividing the acres of modeled habitat rated 0.5 and above by the total acres of modeled habitat in the unit. When the model was run, the latest available vegetation mapping was utilized; however, the vegetation mapping may not account for areas that have burned, been developed, or degraded by nonnative annual grasses since the date of the mapping. Therefore, habitat quality in some areas has the potential to be of lower quality than the model indicates, resulting in an overestimation of habitat quality in some areas. However, as of the writing of this document, this is the best information available to us for the purposes of this assessment. This model was only applied and validated for the Southern California portion of the range by Preston *et al.* (2020); therefore, we are unable to estimate the current condition of habitat suitability in Mexico (Figure 17).

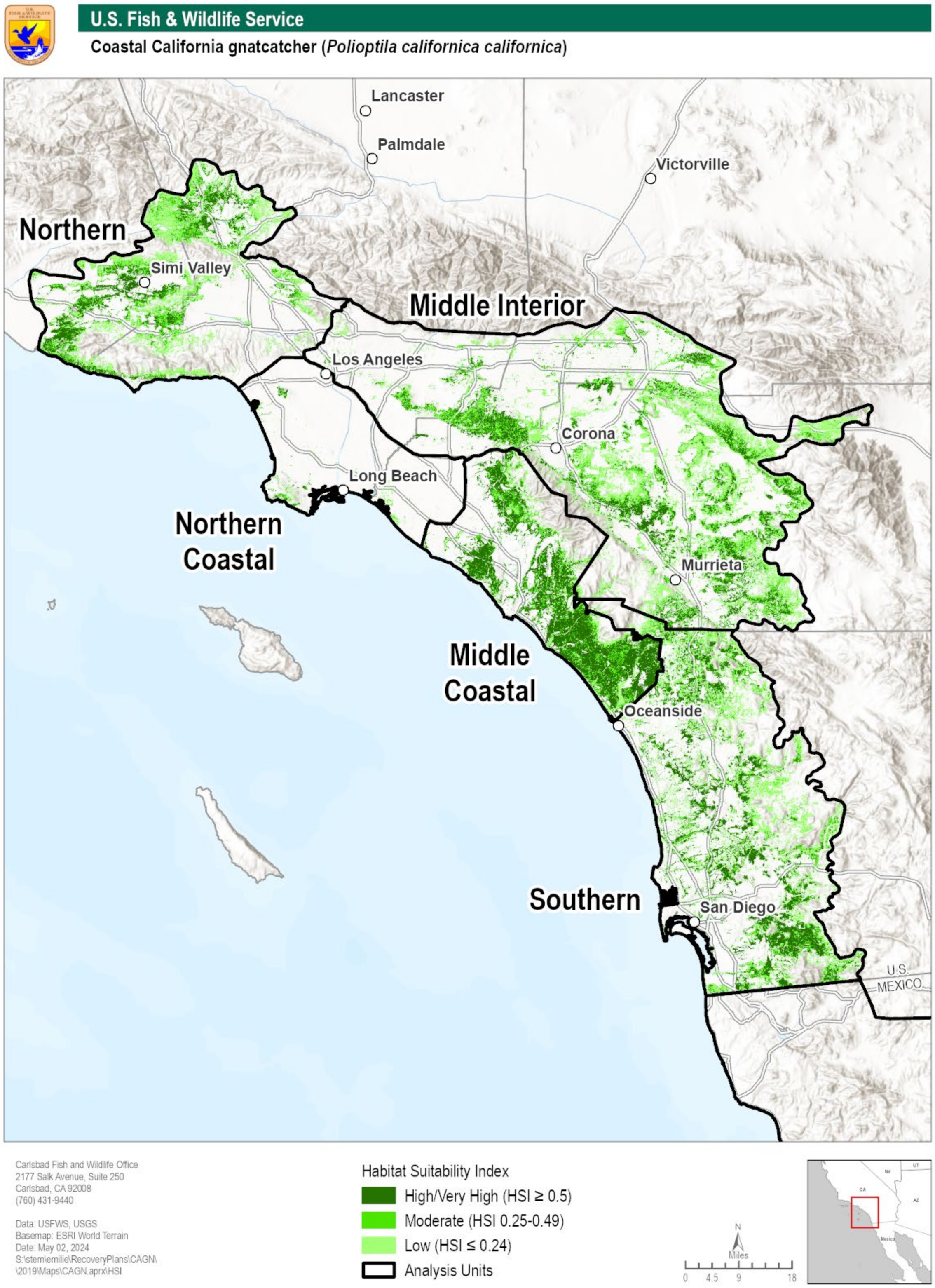

Figure 17. Map of gnatcatcher analysis units displaying high-, moderate-, and low-suitability habitat (Preston *et al.* 2020*, entire)*.

Habitat Quantity

For habitat quantity, we looked at the acres of habitat modeled as moderate, high, and very high quality according to the USGS HSI model (Preston *et al.* 2020, entire). Although habitat rated as high and very high are more closely associated with gnatcatcher occupancy (Vandergast *et al.* 2019, p. 9), we chose to also include the habitat rated as moderate because we believe moderate-quality habitat is important for providing connectivity between patches of higher quality areas and provide corridors for dispersal. Habitat was considered high and very high if the HSI was 0.5 and greater, moderate if HSI was 0.25–0.49, and low if it was below 0.25. To assign our condition categories, a high condition was assigned to analysis units with 150,000 ac (60,702 ha) or more of moderate- or better-quality habitat, a moderate condition was given if the analysis unit contained between 75,000 and 150,000 ac (30,351–60,702 ha) of moderate- or better-quality habitat, and low condition was given to analysis units with less than 75,000 ac (30,351 ha) of moderate- or better-quality habitat. We chose these acreage limits under the assumption that larger acreages of suitable habitat will in turn be more likely to support healthy populations of gnatcatchers and provide greater connectivity. Once more, because of the vegetation mapping utilized in the habitat suitability model, areas where recent fires have occurred may be overestimated for habitat suitability. This, in turn, leads to the potential that habitat quantity may be overestimated in some areas as well. Additionally, because it would not be appropriate to apply the habitat model to the range in Mexico, we are unable to estimate condition for the quantity of moderate- and high-quality habitat in Baja California.

Habitat Connectivity

In 2019, USGS conducted a study to assess genetic connectivity and diversity of the coastal California gnatcatcher aggregations in Southern California (Vandergast *et al.* 2019, entire). With the exception of outlying aggregations in the northern portion of the range, the study indicated that gnatcatchers are retaining genetic similarity and have large effective population sizes throughout most of their range (Vandergast *et al.* 2019, p. 7). This study has also led researchers to believe that dispersal of individuals is less limited than was previously estimated from banding studies (Vandergast *et al.* 2019, p. 7). When looking at geographic distances of first order relatives, the researchers found relative pairs among most aggregations except for within the Ventura, Palos Verdes, and Coyote Hills areas, which did not share any relative pairs with any other aggregation (Vandergast *et al.* 2019, pp. 5–6). Chino Hills and San Joaquin Hills were also observed to have decreased dispersal (Vandergast *et al.* 2019, pp. 5–6). While this indicates that recent habitat fragmentation has not resulted in the genetic isolation of birds separated by intervening areas of unsuitable habitat throughout most of the subspecies' range, emergent patterns of genetic differentiation among the northern subpopulations suggest increases in isolation and fragmentation of habitat remains of concern because it can lead to a loss of connectivity among subpopulations. Areas with the greatest impacts from urbanization, namely the northern portion of the range (Ventura and Los Angeles counties), have experienced increased isolation and decreased genetic diversity (Vandergast *et al.* 2019, p. 7). Additionally, the researchers developed a habitat suitability model (Preston *et al.* 2020, entire) to assess the relationship between available habitat and genetic diversity.

To assess connectivity, we utilized the relationship observed by Vandergast *et al.* (2019, pp. 3–6) between allelic richness and percent suitable habitat in a 30 km (18.6 mi) buffer surrounding gnatcatcher aggregations. They found that allelic richness was positively associated with the availability of suitable habitat and that genetic diversity steeply declined when available suitable habitat within the 30 km of gnatcatcher occurrences fell below 10 percent (Vandergast *et al.* 2019, pp. 3–4; Figure 18).

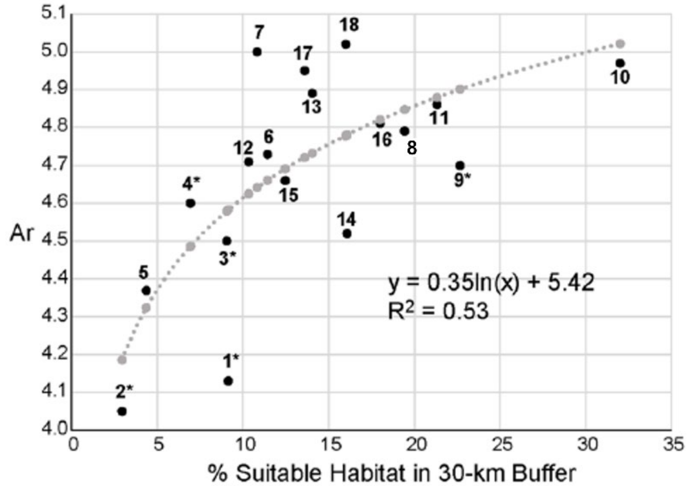

Figure 18. A logarithmic relationship was reported between allelic richness (A_r) and percent suitable habitat of total land area within a 30-km buffers. Data points are shown in black and model predictions are shown in gray. Numbers represent regional aggregations of gnatcatchers used in genetic analysis. (Caption and figure from Vandergast *et al.* 2019, p. 6).

Allelic richness is a measure of genetic diversity that can indicate a population's potential to adapt and persist over time. Well-connected populations experience higher levels of gene flow, increasing allelic richness. We reasoned areas with higher allelic richness likely represent areas of higher connectivity (through movement of individuals). However, the information available in Vandergast *et al.* (2019) did not cover the full area within each of the analysis units. To extrapolate to the gnatcatcher's Southern California range, we mapped center points in a 15 km-by-15 km grid across the entire range of the gnatcatcher and calculated the percent suitable habitat (HSI 0.5 and above) in relation to the total land cover within a 30 km (18.6 mi) radius around each point (Figure 19). A 30 km (18.6 mi) radius was chosen to correlate with the mean gnatcatcher dispersal distance among relatives inferred in Vandergast *et al.* (2019, pp. 4, 9–10). To estimate connectivity within each of the respective units, an average of percent suitable habitat around all center points within a unit was calculated (Figure 19). If the average percent of suitable habitat within 30 km was 10 percent or larger, we gave it a high condition score; if the average percentage was 5 to 10 percent, we gave it a moderate condition score. A low condition score was given to AUs with less than 5 percent average suitable habitat in a 30 km radius. Areas within buffer radii that included the Pacific Ocean or Mexico were excluded from the calculations, consistent with methods used in Vandergast *et al.* (2019). Due to lack of information, we are unable to estimate the current condition of connectivity in Mexico.

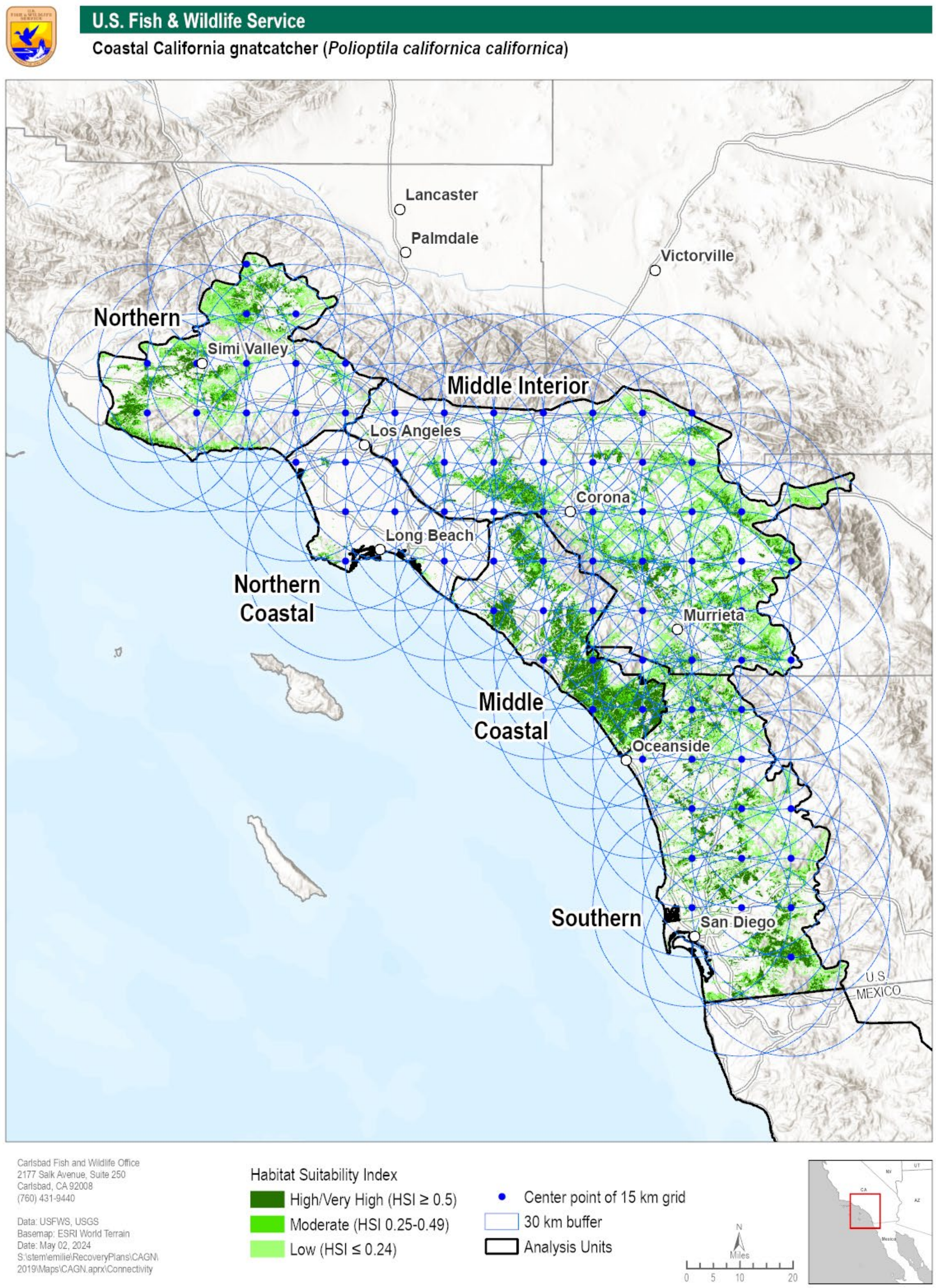

Figure 19. Coastal California gnatcatcher connectivity analysis. Connectivity was estimated within each analysis unit by analyzing the amount of suitable habitat averaged across each of the 15 km grids.

Effective Population Size

Using a linkage disequilibrium method and assuming random mating, Vandergast *et al.* (2022, p. 1206 and 1209) estimated the contemporary effective population size (N_e) for the coastal California gnatcatcher subspecies in Southern California and the other subspecies in Baja California. For coastal California gnatcatcher, Vandergast *et al.* (2022, p. 1209) reports an effective population size of 695 (95% confidence interval [CI]: 451–2,063). This is similar to and has overlapping confidence intervals as previous estimates, which estimated an effective population of 1,025.8 (95% CIs: 669.8–2,049) and 2,139 (95% CIs: 1,694–2,964) (Vandergast *et al.* 2019, p. 6).

Effective population size was assessed at the rangewide population level because the coastal California gnatcatcher appears to function as one population. According to Frankham *et al.* (2014, entire), a population should have a minimum effective population size of 100 to avoid short-term inbreeding depression, and a minimum effective population size of 1,000 to maintain long-term genetic fitness (i.e., evolutionary potential). We therefore defined a high condition as an effective population above 1,000, a moderate condition was defined as an effective population between 100 and 1,000, and a low condition was given for an effective population size below 100.

Occupancy

Occupancy within conserved habitat, military land and otherwise publicly accessible open space was assessed at the regional scale. The SDMMP, in partnership with USGS, CDFW, USFWS and the subregional conservation plan implementing entities initiated a standardized, regional monitoring program for the gnatcatcher in 2016. Goals of this monitoring program include 1) tracking trends in habitat occupancy over time to gain a greater understanding of the regional status of the gnatcatcher, 2) identify associations of biotic (i.e., vegetation) and abiotic environmental variables with gnatcatcher occupancy and local habitat colonization and extinction events, and 3) assess the effects of fire on gnatcatcher occupancy rates throughout Southern California. The goal is to repeat this monitoring every 4 years; as of this writing, this monitoring was performed in 2016 and 2020. Results of the Regional Monitoring study are preliminary and only include data from two points in time; therefore, it is difficult to come to conclusions about long-term trends. However, this monitoring provides the most comprehensive and up to date regionwide assessment of the status of the subspecies at present. Occupancy data are not available for gnatcatchers in Mexico; therefore, we are unable to assess the demographic condition of the population in Baja California.

6.2 ANALYSIS OF HABITAT FACTORS

In this section, we assess the condition of habitat factors (habitat suitability, habitat quantity, and connectivity) within each analysis unit.

Northern Analysis Unit

Figure 20. The Northern Analysis Unit (NAU) location and overall condition of habitat factors.

The Northern Analysis Unit (NAU) encompasses the Ventura County portion of the subspecies' range and northwestern Los Angeles County located north of Santa Monica and west of Pasadena using State Route 2 as the southern boundary line (Figure 20). The NAU includes the areas of Santa Clarita, Simi Valley, Thousand Oaks, and the San Fernando Valley. Coastal California gnatcatchers in the NAU are sporadically distributed and appear to be becoming genetically isolated from the individuals in the southern parts of the range. Core populations of gnatcatchers in the NAU occur in the Thousand Oaks, Moorpark, and Simi Valley areas and sporadically in the Santa Clarita area (Cooper *et al.* 2017, p. 127). The NAU is made up mostly of private lands that largely have not been surveyed (Appendix B), so the degree of occupancy between these core areas is unknown (Cooper *et al.* 2017, p.127). Historically, populations were once common in the eastern San Fernando Valley and lower Santa Clarita River valley but are now considered potentially extirpated from these portions of the analysis unit (Cooper *et al.* 2017, pp. 131–132).

The NAU is approximately 747,046 ac (302,319 ha), with approximately 256,508 ac (103,805 ha) of modeled gnatcatcher habitat. Of the modeled habitat available for gnatcatchers, 26 percent is high- or very high-quality habitat, 22 percent is considered moderate quality, and 52 percent is considered low-quality habitat. Because the highest quality habitat accounts for less than 30 percent of the modeled habitat in the unit, a low condition was given to the NAU for habitat suitability. Habitat quantity was given a moderate condition, with the quantity of moderate- and better-quality habitat totaling 123,256 ac (49,879 ha). The NAU is comprised largely of private land (75 percent) and no HCPs or management plans exist in this area (Appendix B). Out of the total modeled habitat throughout the NAU, 11 percent is considered conserved. The average percent of habitat within a 30 km (18.6 mile) range throughout the NAU is 5.2 percent, giving it a moderate connectivity condition score. Considering all the condition categories, the overall current condition for habitat factors of the NAU is moderate (Table 11).

Northern Coastal Analysis Unit

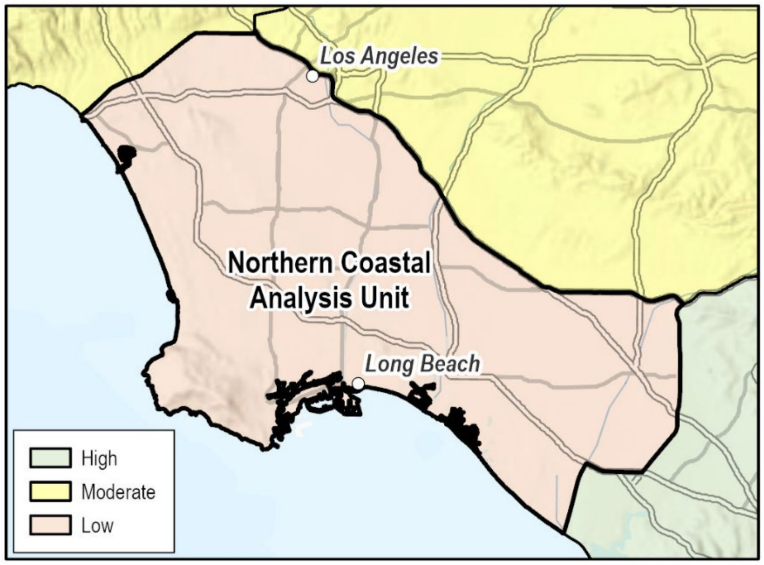

Figure 21. The Northern Coastal Analysis Unit (NCAU) location and overall condition of habitat factors.

The Northern Coastal Analysis Unit (NCAU) includes the area within the Rancho Palos Verdes NCCP/HCP and encompasses the coastal area of Los Angeles County south of Santa Monica and west of Interstate 5, and the northern portion of Orange County west of State Route 91 (Figure 21). The analysis unit is highly urbanized and comprised mostly of private land (Appendix B). Gnatcatchers in the NCAU are mostly confined to the Palos Verdes Peninsula, which is bordered by the Pacific Ocean on three sides and the Los Angeles metropolitan area on the other.

The NCAU is approximately 383,942 ac (155,375 ha) with approximately 13,310 ac (5,386 ha) of modeled gnatcatcher habitat. Of the modeled habitat available for gnatcatchers, 23 percent is high or very high quality, 24 percent is moderate quality, and 53 percent is low quality. Because less than 30 percent of the habitat is high quality, the NCAU was given a low condition score for habitat suitability. The acres of available habitat are also low, with a combined total of 6,298 ac of high-, very high-, and moderate-quality habitat. The NCAU is comprised largely of private land (93 percent; Appendix B) and of the small amount of modeled habitat throughout the unit, 40 percent is conserved. The gnatcatchers in the NCAU are quite isolated and the unit was given a low condition score for connectivity due to the average percent of suitable habitat within a 30 km buffer throughout the area being 2.7 percent. Considering all the condition categories, the overall current condition for habitat factors of the NCAU is low (Table 11).

Middle Coastal Analysis Unit

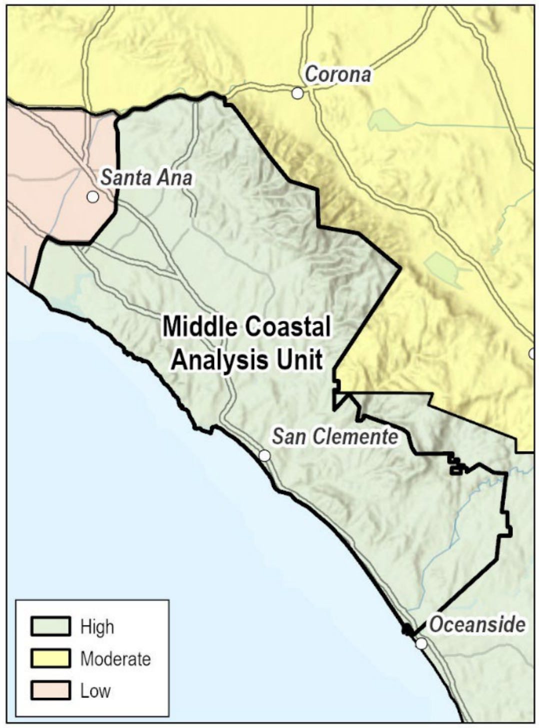

Figure 22. The Middle Coastal Analysis Unit (MCAU) location and overall condition of habitat factors.

The Middle Coastal Analysis Unit (MCAU) includes the areas within the Orange County Central/Coastal NCCP, Orange County Southern Subregion HCP, and Marine Corps Base Camp Pendleton (MCB Camp Pendleton) and Naval Weapons Station Seal Beach Detachment Fallbrook (Detachment Fallbrook) (Figure 22). Gnatcatchers in the MCAU are broadly distributed and highly connected to birds in the analysis units to the east and south. Landownership is almost evenly split between Federal and private lands (40 percent and 47 percent, respectively; Appendix B) and for the purposes of this analysis, we consider most of the area as conserved (includes habitat that is being managed for the subspecies and is not at risk of development) because of the implemented HCPs and the respective Integrated Natural Resource Management Plans (INRMP) at MCB Camp Pendleton and Detachment Fallbrook that provide management for gnatcatchers (see Appendix A for more information).

The MCAU is approximately 474,644 ac (192,081 ha), with approximately 239,960 ac (97,108 ha) of modeled gnatcatcher habitat. Of the modeled habitat available for gnatcatchers, 63 percent is high- or very high-quality habitat, 18 percent is considered moderate quality, and 18 percent is considered low-quality habitat; therefore, a high condition was given to this region for habitat suitability. With 196,029 ac (79,330 hectares) of moderate- and better-quality habitat available for gnatcatchers, it was given a high condition score for habitat quantity. Of the modeled habitat within the MCAU, 88 percent is considered conserved. The gnatcatchers in the unit are well connected to the rest of the range with the average percent of suitable habitat within a 30 km buffer throughout the unit at 20.9 percent. Therefore, a high condition score was given for connectivity. Considering all the condition categories, the overall current condition for habitat factors of the MCAU is high (Table 11).

Middle Interior Analysis Unit

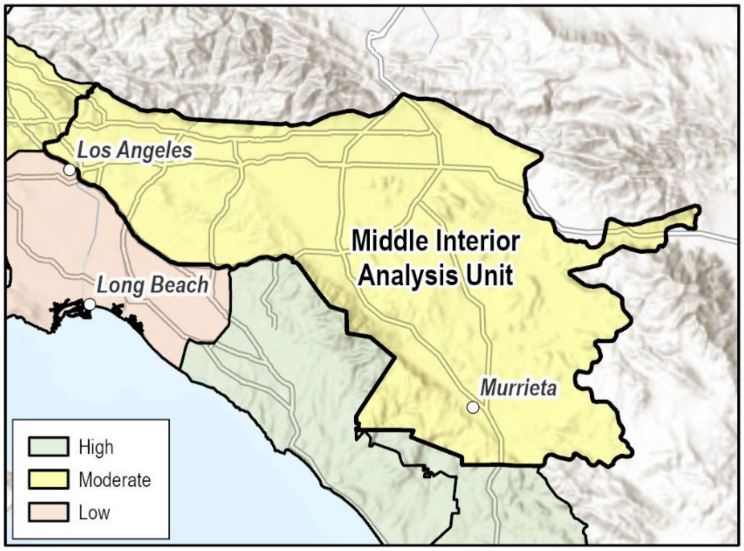

Figure 23. The Middle Interior Analysis Unit (MIAU) location and overall condition of habitat factors.

The Middle Interior Analysis Unit (MIAU) includes the portion of Los Angeles County east of Interstate 5 to the San Gabriel Mountains, the Chino Hills area of Orange County, San Bernardino County south of the San Gabriel Mountains and west of the San Bernardino Mountains, and the Western Riverside MSHCP west of the San Jacinto Mountains (Figure 23). A small portion of the MIAU extends into the San Gorgonio Pass in Riverside County, which is not addressed as a portion of the Western Riverside MSHCP. The MIAU includes the areas of San Dimas, Chino Hills, Coyote Hills, southwestern San Bernardino County, and Western Riverside. Gnatcatchers in the MIAU are fairly continuously distributed in the southwestern areas of the unit, particularly in the Riverside Lowlands, San Jacinto Foothills, the Interstate 15 and Interstate 215 corridors from the Santa Ana River to Temecula, and into the Vail Lake/Wilson Valley area (Biological Monitoring Program 2019, p. 1). Towards the northern areas of the MIAU, distribution of gnatcatchers becomes more sporadic. The MIAU is made up mostly of private lands (Appendix B) and includes lands that are currently or proposed to be conserved by the Western Riverside MSHCP.

The MIAU is approximately 1,593,794 ac (644,985 ha), with approximately 525,805 ac (212,785 ha) of modeled gnatcatcher habitat. Of the modeled habitat available for gnatcatchers, 25 percent is high or very high quality, 22 percent is moderate quality, and 53 percent is low quality. Because the percentage of suitable habitat is less than 30 percent, it was given a low condition score. While the habitat suitability is mostly low, there is greater than 200,000 ac (80,937 ha) of available habitat, so it was given a high condition for habitat quantity. The MIAU is comprised of approximately 83 percent private lands, and of the total modeled habitat within the unit, 24 percent is considered conserved. The gnatcatchers in the MIAC are moderately well connected, with the average percent of suitable habitat within a 30 km buffer throughout the unit at 7.2 percent. Considering all the condition categories, the overall current condition for habitat factors of the MIAU is moderate (Table 11).

Southern Analysis Unit

Figure 24. The Southern Analysis Unit (SAU) location and overall condition of habitat factors.

The Southern Analysis Unit (SAU) includes the portion of gnatcatcher's range within San Diego County except for MCB Camp Pendleton and Naval Weapons Station Seal Beach Detachment Fallbrook (Figure 24). Multiple regional conservation plans/programs cover the range of the gnatcatcher throughout this area including the San Diego MHCP, San Diego MSCP, and North County MSCP plan. It also includes the Department of Defense-owned Marine Corps Air Station Miramar, which has an INRMP that addresses the gnatcatcher and its habitat. Gnatcatchers are well distributed throughout the more coastal portions of the SAU and are uncommon towards the more inland areas where habitat suitability is lower. The SAU is made up of mostly private lands (Appendix B), but gnatcatchers remain well connected via conservation of core and linkage habitat included within the habitat reserves created by the implemented NCCP/HCPs that cover the area.

The SAU is approximately 1,027,304 ac (415,735 ha), with 370,771 ac (150,045 ha) of modeled gnatcatcher habitat. Of the modeled habitat available for gnatcatchers, 34 percent is high quality, 19 percent is moderate quality, and 47 percent is low quality. Thus, habitat suitability was given a moderate condition score. There is 197,212 ac of moderate- and better-quality habitat available, so a high condition score was given for habitat quantity. The SAU is comprised mostly of private lands, and of the modeled habitat within the unit, 40 percent is considered conserved. The gnatcatchers in the SAU appear to be well connected to gnatcatchers in the other analysis units within Southern California except for the geographically outlying or isolated aggregations of gnatcatchers at the northern edge of the range. Throughout the unit, the average percent suitable habitat within a 30 km buffer is 12.9 percent. Considering all the condition categories, the overall current condition for habitat factors of the Southern Analysis Unit is high (Table 11).

Baja California Analysis Unit

Figure 25. The Baja California Analysis Unit (BCAU) location and likely overall condition of habitat factors.

The Baja California Analysis Unit (BCAU) includes the portion of the gnatcatcher range in Mexico (Figure 25). The BCAU includes all areas from the United States-Mexico border south to approximately Ensenada, Mexico, at about 32 degrees north latitude. While we are not aware of any recent, systematic surveys or estimates of the gnatcatcher population in Baja, eBird data suggests they are distributed sporadically throughout the unit and mostly concentrated to the lower elevation coastal areas (eBird 2022, web). The habitat suitability model developed for the Southern California portion of the range was not developed or evaluated to determine if it provides a reasonable representation of gnatcatcher habitat in Mexico; therefore, we are unable to assess the habitat condition in this portion of the subspecies' range in a way that is equivalent to our assessment of the Southern California portion of the range. Instead, we offer a coarse qualitative assessment of the habitat conditions in Mexico based on available information. To estimate the quantity of CSS in the BCAU, we used updated GIS data from the Instituto Nacional de Estadística y Geografía (National Institute of Statistics and Geography; INEGI 2018), which maintains data on the distribution and characteristics of vegetation and soil types, water bodies, and climate, among other things, throughout Mexico. Using the geographical data from INEGI, we assessed vegetation types most closely associated with gnatcatcher locations to estimate acres of appropriate habitat within the range of the gnatcatcher in Mexico. We are unable to quantitatively determine the quality and connectivity of gnatcatcher habitat in the BCAU, but a qualitative discussion is below.

The BCAU is approximately 824,561 ac (333,688 ha), with an estimated 10,597 ac (4,288 ha) of appropriate gnatcatcher habitat from the United States-Mexico border to 32° N. In addition to the appropriate gnatcatcher habitat, there appears to be large areas of marginal habitat as well (i.e., areas that appear suitable for dispersal but not for breeding. Habitat types we considered marginal are chapparal and coastal rosette scrub and shrubland). We estimate these areas of marginal habitat to be approximately 116,511 ac (47,150 ha) throughout the unit (INEGI 2018). In all, most habitat areas in the BCAU appear to be unsuitable for the coastal California gnatcatcher and of the habitat areas present in the BCAU nearly 60 percent (483,870 ac (195,815 ha)) is classified as chapparal, a habitat type not utilized by the gnatcatcher for breeding (INEGI 2018). Further, approximately 188,498 ac (76,282 ha), or 23 percent, of the BCAU is urbanized or agricultural land (INEGI 2018). Although these habitat classification estimates are coarse, we believe it reflects the potential habitat available throughout the range of the coastal California gnatcatcher in Mexico as we currently understand it. In all, the lack of appropriate habitat and high amounts of urbanized and agricultural areas, likely results in a low condition for habitat quantity. In terms of quality, most of the habitat available for gnatcatchers throughout the unit is marginal, leading to a likely low condition for habitat suitability. For connectivity, the large amounts of urbanization (especially the Tijuana region) and agriculture, in combination with lack of suitable habitat, is likely having a limiting factor on how well connected the birds in the BCAU may be to the rest of the range; so, we estimate connectivity is also in low condition. In summary, when subjectively compared with the Southern California analysis units, the overall condition of the BCAU appears to be low, given the acres of potentially suitable habitat and level of gnatcatcher detections.

Table 10. Analysis results of habitat conditions by analysis unit (Habitat suitability model from Preston *et al.* 2020, entire).

Geographic Analysis Unit	Approximate Size of Unit (acres)	Acres of Modeled habitat	Percent modeled habitat greater than or equal to 0.5 HSI (acres)	Acres of very high, high, and moderate habitat (HSI ≥ 0.25)	Percent suitable habitat within 30 km buffer (HSI ≥ 0.5)	Percent of Modeled Habitat Conserved (acres)
NAU	747,046	287,361	24% (69,690)	132,157	5%	11% (31,788)
NCAU	383,942	15,091	23% (3,415)	7,189	3%	40% (6,003)
MCAU	724,301	246,707	63% (156,035)	201,448	22%	86% (211,590)
MIAU	1,593,794	574,608	24% (135,238)	261,085	8%	24% (137,473)
SAU	1,161,586	518,419	35% (142,950)	219,915	14%	52% (268,852)
BCAU	824,561	10,597[4]	Unknown	Unknown	Unknown	Unknown

[4] Habitat quantity estimate for the BCAU is not based on the habitat suitability model and instead uses data from INEGI (2018).

6.3 ANALYSIS OF DEMOGRAPHIC FACTORS

Accurate historical population trend estimates for the gnatcatcher are not available, as no systematic surveys have occurred throughout the subspecies' range. However, ornithological records from the 1940s note the gnatcatcher as "common locally" despite reductions in the quantity of suitable habitat (Grinnell and Miller 1944, p. 369). By the 1960s, the population of the coastal California gnatcatcher declined drastically, and the subspecies was recorded as "very rare" (Pyle, R. L. and Small 1961, p. 49). Although the decline of gnatcatcher habitat and abundance continued to be observed (Atwood 1980, p. 76; Garrett and Dunn 1981, p. 292; Unitt 1984, p. 177), very few quantitative estimates were made until the 1980s and 1990s when estimates ranging from 1,000–2,000 pairs were made using several methodologies (Atwood 1980, p. 76; MBA 1991, p. 5; Atwood 1992, pp. 3–4). At the time of listing, we estimated about 2,562 pairs of gnatcatchers remained in the United States, and we reported about 2,800 pairs occurred in Baja California (USFWS 1993, p. 1674) (based on the range extending to 30°N latitude). More recently, we reported an estimate of 1,324 gnatcatcher pairs over a 111,006-acre (44,923-ha) area on lands owned by city, county, State, and Federal agencies (public and quasi-public lands) of Orange and San Diego counties (USFWS 2010, p. 8). However, the study used as a basis for this estimate sampled only public lands within the coastal regions of the subspecies' range in Southern California (Winchell and Doherty 2008, p. 1,324). Because these estimates were projected for different portions of the subspecies' range and relied on different methods and sources of information, they are not appropriate for inferring trends in rangewide population abundance or habitat occupancy.

More recently, Vandergast *et al.* (2022, entire) analyzed the genetic structure of coastal California gnatcatcher throughout the range, which included estimating the effective population size—or the number of breeding individuals in a population—for Southern California. Because effective population size estimates only take into consideration the breeding portion of the population, effective population sizes are typically smaller than census population size estimates, such as those discussed above. The effective population size for coastal California gnatcatcher in Southern California was reported as 695 (95% CIs: 451–2063) (Vandergast *et al.* 2022, p. 1209), which was not significantly different from previous effective population size estimates of 1,025.8 (95% CIs: 669.8-2049) and 2,139 (95% CIs: 1694-2964) estimated from different genetic marker sets and statistical methods (Vandergast *et al.* 2019, pp. 6, 9–10).

Although standardized, rangewide population trends and habitat occupancy estimates (within the United States or Mexico) are not currently available, the USFWS is working with partners to develop and implement a long-term regional monitoring program for the coastal California gnatcatcher in Southern California to assist with future estimates. This will provide us with a better understanding of gnatcatcher population status and trends, as well as information to identify habitat attributes and threats that influence gnatcatcher occupancy. Over the long-term, we will be able to assess the population status of the coastal California gnatcatcher more accurately and, in turn, help inform management decisions. The first regional coastal California gnatcatcher survey took place in 2016 and is anticipated to be repeated every 4 years. In 2016, regional gnatcatcher occupancy was 0.23 (95% CIs 0.17-0.29; subregional estimates for San Diego and Orange County were 0.20 (95% CIs 0.12-0.28) and 0.30 (95% CIs 0.20-0.40), respectively (Kus et al. 2024, p. 27). In 2020, occupancy increased 23 percent regionally (0.29: 95% CIs 0.25-0.34), 32 percent in San Diego (0.26: 95% C.I. 0.19-0.32), and 22 percent in Orange County (0.36: 95% CIs 0.29-0.44)) (Kus 2023, pers. comm.).

The demographic needs (effective population size and occupancy) were assessed for the gnatcatcher at the rangewide scale because the categories were not applicable to the analysis unit level. As stated above, current recommendations for a population to avoid inbreeding depression is suggested to have a minimum effective population size of 100, and a minimum population size of 1,000 to retain long-term adaptive capacity (Frankham *et al.* 2014, entire). In Southern California, the effective population was recently estimated at 695 (95% CIs: 451–2,063) (Vandergast *et al.* 2022, p. 1209), 1,025.8 (95% CIs: 669.8–2049), and 2,139; (95% CIs: 1,694–2,964) (Vandergast *et al.* 2019, p. 6) depending on the method of estimation used. These estimates suggest that the effective population size of the coastal California gnatcatcher is above the recommended size to reduce inbreeding depression (effective population of at least 100) and may or may not be above the recommendation to retain long-term adaptive capacity (effective population of at least 1,000) (Vandergast *et al.* 2022, p. 1213). Thus, effective population size was given a moderate demographic condition score.

For regional occupancy, preliminary results from regional surveys completed in 2016 showed that gnatcatcher occupancy rangewide within habitat modeled as having high to very high habitat suitability was around 23 percent (Kus 2017, presentation). This is comparable to the habitat occupancy rate (24 percent) for similar quality habitat that was burned in San Diego County 6 to 13 years prior (i.e., burned between 2003 and 2010) suggesting fire history likely contributes to and regulates regional habitat occupancy rates. In 2016 within San Diego County, the habitat occupancy rate was estimated to be 41 percent in areas of high- and very high-quality habitat where there was no recent fire history. In 2020, while habitat continued to recover from fire and additional habitat had burned since 2016, the regional habitat occupancy estimate was 27 percent, representing a regional increase in occupancy of approximately 17 percent (Kus 2020, SDMMP Annual Monitoring and Management Meeting). Granted, occupancy can be highly variable based on the time since the area was burned, fire severity, and the rainfall patterns following fire. In essence, this increase in occupancy may be attributable to the resumption of normal to near normal rainfall that arrived at the end of a long drought period, resulting in increased habitat suitability which then positively impacted gnatcatcher fecundity. Overall, the increase in the regional occupancy rate suggests the rangewide gnatcatcher population maintains resiliency to respond to periods of drought and fire; however, these results are based on only two regional survey efforts. As regional monitoring continues, trends in gnatcatcher occupancy can be better determined. Additionally, fires are continuing to affect gnatcatcher habitat at the regional scale so future trends will be important to continue monitoring. We have no rigorous information on coastal California gnatcatcher occupancy in Mexico; however, anecdotal information suggests that the subspecies is not as common as in the Southern California units and is restricted to suitable habitat in the lower elevation coastal areas. This is likely because there is very little suitable CSS habitat and high levels of urban and agricultural land in this analysis unit. Thus, in all, because of the apparent increase in regional gnatcatcher occupancy, we gave occupancy a high demographic condition score.

6.4 SUMMARY OF CURRENT CONDITIONS

Current Species Resiliency

To summarize population resiliency for the coastal California gnatcatcher, we evaluated the condition of habitat needs and demographic needs. Habitat needs were ranked for each analysis unit based on our best assessment of resource conditions within each unit (Table 11, Table 12). Of the analysis units assessed in Southern California, two currently have high condition, two have moderate condition, and one has low condition. While there is a large amount of uncertainty associated with the amount of CSS in the BCAU, it appears likely that the overall habitat condition in Mexico is low. As such, this gives an overall moderate condition for habitat conditions.

We assessed demographic conditions at the rangewide scale using the factors of effective population size and occupancy. In most of Southern California, gnatcatchers appear to be maintaining an effective population high enough to reduce inbreeding depression (N_e greater than 100) and may or may not be above the recommended threshold for retaining long-term adaptive capacity (N_e greater than 1,000). For occupancy, preliminary occupancy estimates appear to show an increasing trend, although localized estimates of occupancy are highly dependent on time since fire and pre-fire habitat quality. Therefore, effective population size was given a moderate condition score and occupancy was given a high condition score. Rangewide, this indicates the demographic factors for the coastal California gnatcatcher are moderate/high in condition.

Across the analysis units assessed in Southern California, the current habitat conditions for the coastal California gnatcatcher are moderate and the demographic conditions are moderate/high. The subspecies has approximately 1.64 million acres (663,684 ha) of modeled habitat available, of which 821,794 acres (332,568 ha) are moderate quality or higher, and 655,706 acres (265,355 ha) are considered conserved. Our analysis indicates the subspecies is maintaining connectivity throughout most of its U.S. range and retaining an effective population size that is adequate for avoiding inbreeding depression. The habitat and demographic conditions in Mexico are unclear; however, the overall condition in Baja California appears to be markedly lower than the Southern California units. As such, we conclude that the subspecies is maintaining moderate/high resiliency such that it has a high capacity to withstand and recover from stochastic disturbances.

Current Species Redundancy

As described in the Methodology section, above, redundancy describes the ability of a species to withstand catastrophic events. To assess the redundancy of the coastal California gnatcatcher, we look at the number of resilient regions throughout the range, their distribution, and connectivity to determine the likelihood that the subspecies has a margin of safety to withstand catastrophic events. Approximately 1.65 million acres (667,731 ha) of mapped habitat is available for the coastal California gnatcatcher in a long but somewhat discontinuous distribution that extends from Ventura County, California south to approximately 32 degrees north latitude, near Ensenada, Mexico. While past development, agriculture, and vegetation type conversion has contributed to the patchy distribution of the subspecies, the long north-south distribution of the gnatcatcher provides a margin of safety from localized catastrophic events. Therefore, we consider the coastal California gnatcatcher to have sufficient redundancy to withstand catastrophic events.

Of the analysis units assessed, two are in high condition (MCAU and SAU), two are in moderate condition (NAU and MIAU), and one is in low condition (NCAU). In Southern California, most analysis units are well connected and individuals occupying the area are currently operating as a single, genetic population, indicating that gene flow (connectivity) is ongoing (Vandergast *et al.* 2019, p. 5). The exception is in the NAU and NCAU where a greater degree of urban development and less suitable habitat has resulted in isolated areas that show greater genetic structuring, indicating less connectivity. Thus, local-scale resiliency throughout the range varies; for example, in the high resiliency analysis units (SAU and MCAU), if a catastrophic event were to occur, the gnatcatchers in these areas would be more likely to recover due to the high level of connectivity to other analysis units, which could act as a source for recolonization. On the other hand, if a local catastrophic event were to occur in the Palos Verdes area (NCAU), the population there may become extirpated, and due to the area's isolation, natural recolonization may be difficult. However, the extensive distribution of the subspecies and ongoing gene flow indicate that coastal California gnatcatcher is currently able to withstand catastrophic events and extirpation of an entire analysis unit, or the subspecies is unlikely.

Current Species Representation

As described in the Methodology section, above, representation is the ability of a species to adapt to changing environmental conditions. This factor is assessed at the species level. We typically use the breadth of genetic or environmental diversity within and among populations as a surrogate for evolutionary adaptability. When using a spatially continuous approach to look at genetic diversity, we found that allelic richness is lower in the Northern and Northern Coastal Analysis Units, indicating increased isolation of these areas (Vandergast 2021, *in litt.*). However, in a changing climate, the subspecies may need to have the most adaptive capacity at the northernmost portion of its range. Currently, the gnatcatchers in the northernmost portion the range (Ventura, Redlands, Chino Hills, Palos Verdes, Coyote Hills, San Joaquin Hills) have higher genetic divergence and lower genetic diversity than the rest of the range (Vandergast *et al.* 2019, p. 7; Vandergast *et al.* 2022, p. 12). The gnatcatchers in these areas contain unique genetic differences associated with drier and warmer summers and more seasonal precipitation (Vandergast *et al.* 2022, p. 13). These unique genetic variations may be important for adaptive purposes as climate change occurs (Vandergast *et al.* 2022, p. 13). In general, gnatcatchers throughout Southern California are largely a single, genetic population with an effective population size that appears to be adequate for retaining genetic variation and reducing inbreeding depression. The distribution of gnatcatchers in Baja California is lower than in Southern California and the level of connectivity to the rest of the range is impaired by a barrier of urbanization. In terms of environmental diversity, the California gnatcatcher is an obligate species of CSS habitat that ranges from Ventura County, California in the north into Baja California, Mexico in the south. This range encompasses areas across a range of climate variability, with lower temperatures and higher precipitation in the northernmost part of the range compared to drier and warmer conditions further south. In addition, coastal California gnatcatchers occupy three CSS variants throughout the extent of their range, representing a wide degree of environmental diversity. Overall, the gnatcatcher has good adaptive capacity as supported by the breadth of genetic and environmental diversity throughout their range despite being somewhat compromised by barriers to northward dispersal.

CHAPTER 7 - FUTURE CONDITIONS

In this chapter of the SSA, we forecast the coastal California gnatcatcher's response to probable future scenarios of environmental conditions and conservation efforts. We accomplish this by analyzing and describing probable future environmental conditions and the anticipated consequences on the subspecies' ability to sustain populations over time. Once again, we apply the concepts of resiliency, redundancy, and representation to make predictions about the viability of the subspecies into the future.

The future scenarios project the threats discussed earlier in the SSA into the future and considers the impacts those threats may have on gnatcatcher viability under various scenarios. To analyze future conditions, we developed two plausible scenarios to assess how the subspecies needs, threats, and habitat conditions may change over the next 50 years. We chose 50 years because the likelihood and severity of future threats become more uncertain beyond that timeframe. Additionally, NCCP/HCP process has established long-term NCCP/HCPs within the range of the coastal California gnatcatcher that extend out for 50 to 75 years into the future, depending on plan terms and conditions. Therefore, a 50-year timeframe provided the best balance to predict the scope of impacts and the certainty of impacts considered. We constructed these scenarios around four main stressors: urban development, wildland fire, vegetation type conversion, and climate change. While we do expect other stressors on the subspecies to continue (e.g., brood parasitism, grazing, fragmentation), we do not expect them to have a substantial effect on the subspecies or its habitat within the 50-year timeframe.

7.1 Scenario Planning and its Application

Scenario planning is a comprehensive exercise that involves the development of scenarios that capture a range of plausible future conditions. This is followed by an assessment of the potential effects of those scenarios on a given species. Scenarios are not predictions or forecasts of what will happen in the future for a species but are projections or explorations into the range of conditions that may exist based on current information (Figure 27). The scenarios are intended to provide the "upper" and "lower" bounds of plausible conditions based on the information we have (Figure 28), outline uncertainties, and provide decision makers with a means for managing risk and maintaining flexibility in current and future decisions.

Table 11. Current condition table for coastal California gnatcatcher habitat needs within each geographic analysis unit. The available information for the Baja California Analysis Unit is limited and not directly comparable U.S. analysis units.

Geographic Analysis Unit	Habitat Suitability	Habitat Quantity	Connectivity	Overall Condition of Habitat Needs
Northern Analysis Unit	Low	Moderate	Moderate	Moderate
Northern Coastal Analysis Unit	Low	Low	Low	Low
Middle Coastal Analysis Unit	High	High	High	High
Middle Interior Analysis Unit	Low	High	Moderate	Moderate
Southern Analysis Unit	Moderate	High	High	High
Baja California, Mexico	Low (likely)	Low (likely)	Low (likely)	Low (likely)
Rangewide Habitat Condition	**Low**	**High**	**Moderate**	**Moderate**

Table 12. Current condition table for rangewide coastal California gnatcatcher demographic needs.

Effective Population Size	Occupancy	Overall Condition of Demographic Needs
Moderate	High	**Moderate/High**

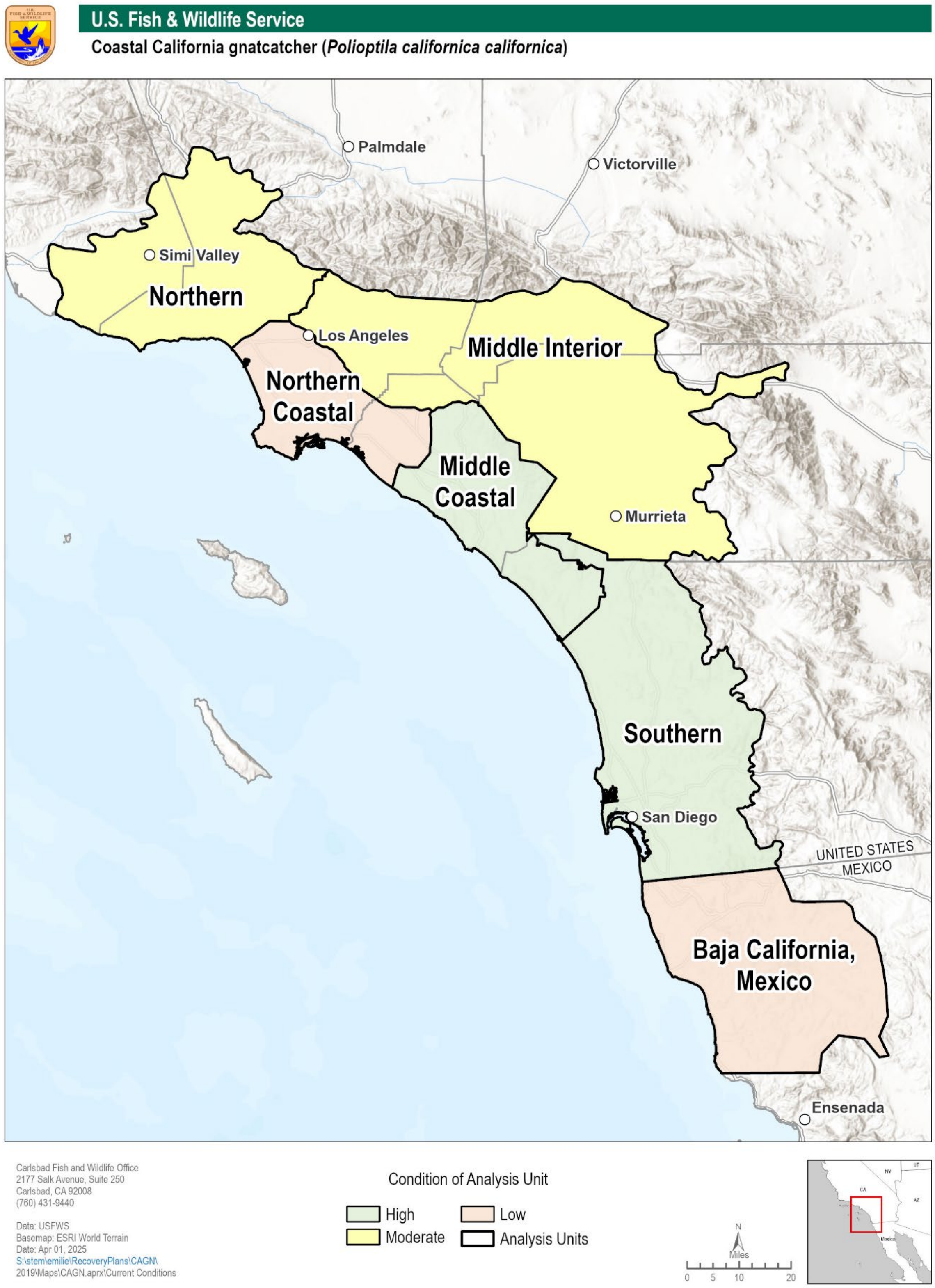

Figure 26. Coastal California gnatcatcher geographic analysis units displaying the current condition of habitat needs.

Developing a range of time frames with a multitude of possible scenarios allows us to create a "risk profile" for a species and its viability into the future. While we do not expect every condition for each scenario to be fully realized, we are using these scenarios as examples for the range of possibilities. For each scenario, we describe the threats that would occur in each Analysis Unit and how they may change in the future. We used the best available science to predict trends in future threats facing the coastal California gnatcatcher. Data availability varies across the range of the subspecies and or Analysis Units. Where data on future threats or trends were not available, we looked to past threats and their trends to evaluate if it is reasonable to assume these trends will continue into future and to what degree.

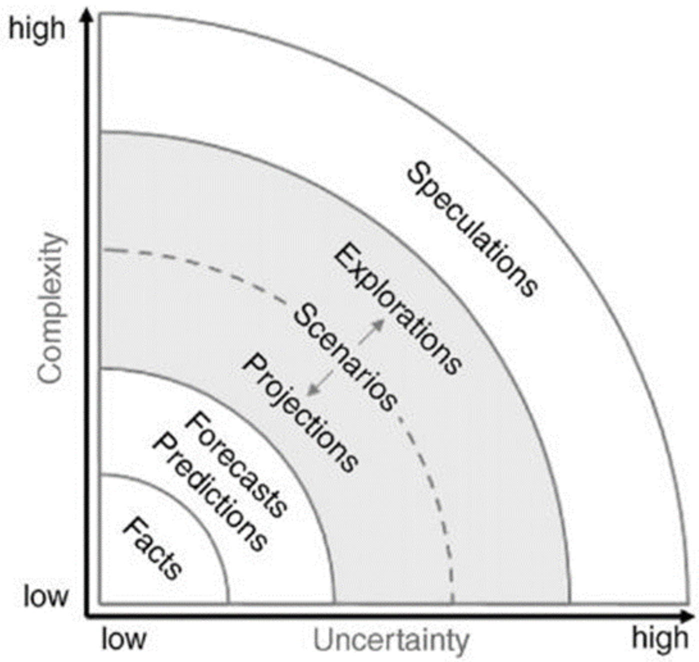

Figure 27. The levels of uncertainty and complexity in situations for which scenarios can be useful in considering future possibilities (adopted from Rowland *et al.* 2014).

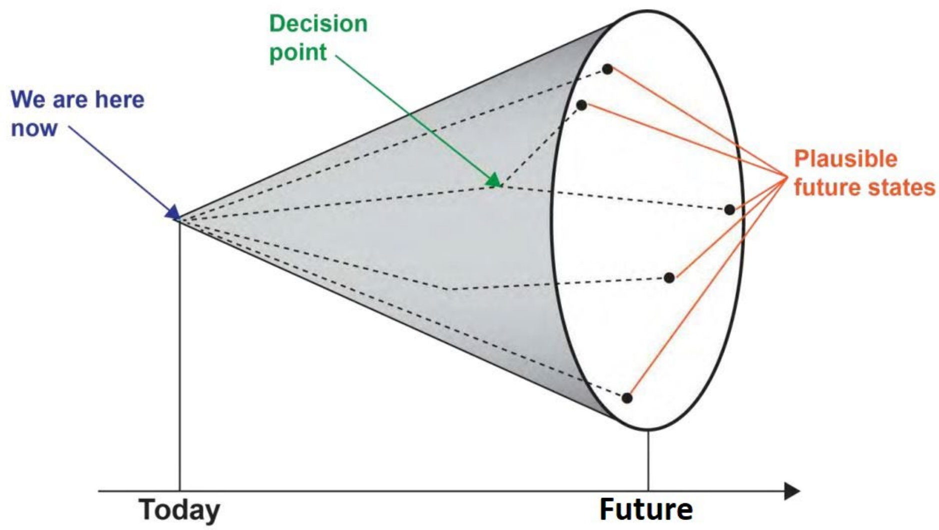

Figure 28. Conceptual diagram of the broadening range of plausible alternative futures as one moves farther away from the present and different events and decision points shift trajectories. (Rowland *et al.* 2014 adapted from BOR 2012).

To analyze future conditions for the coastal California gnatcatcher, we developed two plausible scenarios to assess how subspecies needs, threats, and habitat conditions may change over the next 50 years under two climate models. Using the influences (threats and conservation measures) identified in the *Factors Influencing Viability* section, we focus on those that are likely to have a greater magnitude into the future. The threats we are focusing on for our future scenarios are urban development, wildland fire, vegetation type conversion, and climate change. Agricultural development, grazing, disease, predation, brood parasitism, and fragmentation were not carried forward as the magnitude of impacts were considered low in comparison to the threats included in the analysis and we lack information to characterize the magnitude of these future threats. Due to a lack of information, we are also unable to quantitatively establish the current condition of the Baja California, Mexico portion of the range. While we can fairly predict threats that may continue in this portion of the range, we cannot effectively predict the future condition for this portion of the range without an established baseline (i.e., current condition). Therefore, the Baja California portion of the range was not included in our future scenario analysis. See Table 13 for a summary of the predicted future conditions of each analysis unit as compared to current conditions.

Table 13. Plausible changes in primary threats as compared to current conditions in each of the future scenarios.

Threat	Scenario 1	Scenario 2
Urban development	Approximate 25% increase of acres developed throughout range	Approximate 20% increase of acres developed
Wildland Fire	20% increase of annual acres burned rangewide. Hotter and drier climate conditions increase fire risk and promote shorter fire return interval	5% of increase in annual acres burned rangewide. Warmer and wetter conditions somewhat decrease fire risk, no significant change in fire return interval
Vegetation Type Conversion	Proportion of burned areas burning 2+ times increases by 20% as compared to the previous 40-year period (1981–2020)	Proportion of burned areas burning 2+ times remains the same as the previous 40-year period (1981–2020)
Climate Change - Temperature	Increase Midcentury (2041–2070) RCP 8.5; Hotter/Dryer than current conditions (max temp +3.9 °C; min temp +3.4 °C)	Increase Midcentury (2041–2070) RCP 4.5; Warmer/Wetter than current conditions (max temp +1.9 °C, min temp +3.6 °C)
Climate Change - Precipitation	Decrease Midcentury (2041–2070) RCP 8.5; Hotter/Dryer than current conditions (-0.20mm/day; -73.7mm/year)	Increase Midcentury (2041–2070) RCP 4.5; Warmer/Wetter than current conditions (+0.18mm/day; +66mm/year)

Future habitat loss from urban development over the next 50 years was projected based on land use estimates from the Land Use and Land Cover Projections for California's 4th Climate Assessment database in combination with RCP 4.5 and 8.5 climate scenarios and population growth estimates (Sleeter *et al.* 2017, data). Development is projected to increase with increasing population density and continues to occur throughout the range of coastal California gnatcatcher. As discussed in the *Factors Influencing Viability* section, above, NCCP/HCPs are effectively directing most development away from areas of coastal scrub vegetation in areas where NCCP/HCPs have been adopted or are being planned but much of the northernmost portion of the range is not covered by NCCP/HCPs and no equivalent regulatory mechanism exists in Mexico. Increases in developed land are projected for all Southern California analysis units (Sleeter et al. 2017, data; Table 14). A 25 and 20 percent increase in development was selected for Scenario 1 and 2, respectively. This was based on the projected 23 percent reduction in suitable gnatcatcher habitat rangewide from development in Scenario 1 and a 17 percent reduction is projected in Scenario 2 with the highest proportion of losses occurring in the NAU and MIAU in both scenarios (Sleeter et al. 2017, data). Due to differences between the scale of the models used to project land use changes (coarser) and the model for habitat suitability (finer), the land use classifications do not line up precisely with modeled habitat. To account for this, we calculated the baseline and projected acres classified as "developed" in the land use model that overlapped with the suitability model and applied the predicted change to the modeled habitat to estimate potential acres of future habitat loses in each of our scenarios. Although this may have somewhat overestimated the baseline and projected acres of developed lands, we believe it provides the best estimate of the rate of projected changes under various scenarios that can be expected. Likewise, how development may affect habitat suitability in each unit (i.e., how much high, moderate, or low habitat may be impacted in the future) was not provided through the land use model, but we were able to make projections about habitat quantity. To account for effects of development on habitat suitability, we made three assumptions: 1.) all predicted development occurs in modeled habitat; 2.) for units without NCCP/HCPs, 40 percent will occur in high- and moderate-quality habitat, and 60 percent will occur in low-quality habitat; and 3.) for units with NCCP/HCPs, development will occur 20 percent in high- and moderate-quality habitat, and 80 percent in low-quality habitat. We made this assumption based on the inferences that urban development is likely to sprawl out from already urbanized areas, that lower quality habitat is likely at the edge of urbanized areas, and active NCCP/HCP planning will direct development somewhat away from higher quality habitat areas. We expect the amount of urban and agricultural development will continue to increase in Mexico as well; however, land use projections are unavailable, so we are unable to make quantitative predictions as to the degree of expected land use changes.

Table 14. Baseline (2010) and projected changes in land use based on developed categories (Sleeter *et al.* 2017). The amount of area designated as developed under baseline and two future emissions scenarios are shown for each analysis unit, presented as total acreage, percent of analysis unit, and the percent change from baseline for the future scenarios.

Analysis Unit	Baseline Acres Developed Land	Scenario 1 Acres Developed Land	Scenario 1 Percent Change	Scenario 2 Acres Developed Land	Scenario 2 Percent Change
NAU	112,405	157,429	+40.1%	147,797	+31.5%
NCAU	10,944	11,385	+4.0%	11,105	+1.5%
MCAU	163,585	198,284	+21.2%	194,522	+18.9%
MIAU	265,514	332,207	+25.1%	308,431	+16.2%
SAU	212,380	244,319	+15.0%	230,361	+8.5%
Total Range	**764,828**	**943,624**	**+23%**	**892,216**	**+17%**

Wildland fire is also expected to impact the gnatcatcher and its habitat at some level into the future. Although established NCCP/HCPs include fire management that may reduce the anticipated level of impact from wildland fire, there is no mechanism or conservation measure currently in place that can fully prevent the recurrence of natural or human-caused destructive wildland fires in gnatcatcher habitat. To model future scenarios for wildland fire, we looked at historical acres burned, and Cal-Adapt projections of annual area burned for RCP 4.5 and RCP 8.5 climate models (Cal-Adapt 2018c, data; Cal-Adapt 2018d, data). Over a 40-year period from 1981 to 2020, 723,274 acres (292,699 ha), or 51 percent, of modeled gnatcatcher habitat has burned at least once. Under Scenario 1 conditions, Cal-Adapt projects an 18 percent increase in annual acres burned across the range of the gnatcatcher in Southern California from 2041 to 2070 (Cal-Adapt 2018d, data). In the same period but under Scenario 2 conditions, Cal-Adapt projects a 4 percent increase in annual acres burned (Cal-Adapt 2018c, data). In both scenarios, the highest projected change is predicted to occur in the NAU (Cal-Adapt 2018c, data; Cal-Adapt 2018d, data; Table 15). While we can predict the potential increase in acres burned under our future scenario conditions, models cannot predict where fires will occur. To estimate the effect of potential future fires on coastal California gnatcatcher habitat we looked at what proportion of historical fires burned in each habitat quality type for each unit (i.e., what percentage of total acres burned occurred in high-, moderate-, or low-quality habitat from 1981–2020 for each unit). We then assumed that the predicted acres to burn in each of our future scenarios would occur in the same proportion across habitat qualities as occurred historically. We estimated a 20 percent increase of acres burned rangewide under Scenario 1 compared to a 5 percent increase under Scenario 2 based on the projected increases from Cal-Adapt data (Table 15).

Table 15. Summary of historical acres burned and projected percent increase by analysis unit and under two future emissions scenarios.

Analysis Unit	Historical Acres Burned 1981–2020	Scenario 1 Projected Change	Scenario 1 Projected Acres	Scenario 2 Projected Change	Scenario 2 Projected Acres
NAU	193,438	+30%	251,469	+10%	212,782
NCAU	492	-77%	113	-68%	157
MCAU	120,422	+23%	148,119	+7%	128,852
MIAU	231,483	+13%	261,576	+7%	247,687
SAU	177,439	+10%	195,183	-8%	163,244
Total Range	723,274	+18%	856,460	+4%	752,722

Promoted in large part by the predicted increase in wildland fire, vegetation type conversion of native coastal scrub to nonnative annual grasslands is likely to continue to occur to some extent in the future. While there are many HCPs being implemented throughout Southern California that include fire management priorities, much of the modeled gnatcatcher habitat in Southern California is outside of planning areas and may receive limited beneficial management. According to our analysis, of the modeled habitat that burned in the 40 years from 1981 to 2020, 43 percent has burned 2 or more times (Table 16). The analysis units with the highest amounts of burning multiple times historically are the MIAU, NAU, and SAU. As discussed in the *Factors Influencing Viability* section above, shortened fire return intervals have the potential to promote the conversion of large areas of suitable gnatcatcher habitat to unsuitable nonnative grassland over a relatively short period of time, especially in combination with other factors that promote vegetation type conversion (agricultural activities, nitrogen deposition, edge effects). To project risk of vegetation type conversion, we assume that the proportion of areas burned 2 or more times in the 40 years from 1981 to 2020 will increase by 20 percent in Scenario 1 and will remain the same in Scenario 2 over the next 40 years (Table 17). Again, because models cannot predict exactly where fires will occur, we cannot predict how much of an affect this will have on the amount of high-, moderate-, or low-quality habitat in each unit. To account for this, we looked at the frequency of fires that occurred in each habitat quality from 1981 to 2020 for each unit and made three assumptions: 1.) in Scenario 1, there will be a 20 percent increase in habitat burning 2 or more times for each habitat quality; 2.) In Scenario 2, the proportion of habitat burning 2 or more times in each quality will remain the same as the historical period; and 3.) in both scenarios, of the habitat burning 2 or more times, half will become unsuitable, and half will fall into a lower suitability category.

Table 16. Acres of modeled gnatcatcher habitat burned from 1981 to 2020, acres burned 2 or more times, and the proportion of burned modeled habitat burned 2 or more times.

Analysis Unit	Total Acres of Modeled Habitat	Acres Burned 1981–2020	Acres Burned 2+ Times 1981–2020	Proportion Burned 2+ Times 1981–2020
NAU	256,508	193,438	102,490	53%
NCAU	13,311	492	29	6%
MCAU	239,960	120,422	41,083	34%
MIAU	525,805	231,483	86,336	37%
SAU	370,772	177,439	78,091	44%
Total Range	**1,406,356**	**723,274**	**308,029**	**43%**

Table 17. Summary of projected acres to burn at least once and projection of acres to burn 2+ times by analysis unit and under two future scenarios.

Analysis Unit	Scenario 1 Projected Acres Burned	Scenario 1 Projected Acres Burned 2+ Times	Scenario 1 Proportion Burned 2+ Times	Scenario 2 Projected Acres Burned	Scenario 2 Projected Acres Burned 2+ Times	Scenario 2 Proportion Burned 2+ Times
NAU	251,469	159,934	64%	212,782	112,775	53%
NCAU	113	8	7%	157	10	6%
MCAU	148,119	60,433	41%	128,852	43,810	34%
MIAU	261,576	116,140	44%	247,687	91,644	37%
SAU	195,183	103,057	53%	163,244	71,827	35%
Total Range	**856,460**	**439,572**	**51%**	**752,722**	**320,066**	**43%**

The effects of climate change in the range of the coastal California gnatcatcher are projected to increase annual temperatures and result in more volatile precipitation patterns. These changes may expand or shift the coastal California gnatcatcher's preferred habitat and may also create conditions that favor vegetation type conversion, creating more unsuitable habitat such as nonnative annual grasslands. The best available regional data on current and potential future trends related to climate change, within the range of the coastal California gnatcatcher, indicate that the effects of climate change are a low- to medium-level stressor at the present time that is anticipated to result in shifts to the distribution of the subspecies' habitat and that may potentially affect gnatcatchers at the individual or population level into the future. Using two different climate models, we assessed two future scenarios related to climate change conditions. Scenario 1 forecasts changes based on an RCP 8.5 emissions scenario under hotter and drier conditions. Under these conditions, the annual maximum and minimum temperatures are projected to increase by 3.9 °C and 3.4 °C (7 °F and 6.2 °F), respectively over the next 50 years (Cal-Adapt 2018b, data). The 30-year annual average precipitation is projected to decrease by 73.7 mm (2.9 inches) (Cal-Adapt 2018b, data). Scenario 2 forecasts changes based on an RCP 4.5 emissions scenario under warmer and wetter conditions. In this scenario, the annual maximum and minimum temperatures are projected to increase by 1.9 °C and 2.0 °C (3.5 °F and 3.6 °F), respectively (Cal-Adapt 2018a, data). The 30-year annual average precipitation increases by 66 mm (2.6 in) in this scenario (Cal-Adapt 2018a, data).

Below, we provide a comparison of the plausible changes in how the predominant threats are likely to impact the coastal California gnatcatcher in each scenario over the next 50 years (Table 13). While we can make quantitative predictions about future habitat suitability and habitat quantity using the assumptions outlined above, we are unable to quantitively assess habitat connectivity, so a qualitative assessment is provided based on the current level of connectivity and the predicted future condition of habitat suitability and quantity in each discussion below. Resiliency, redundancy, and representation are also discussed for each scenario to help explain subspecies viability in these future scenarios.

7.2 SCENARIO 1

Scenario 1 is based on an RCP 8.5 emissions scenario under hotter and drier conditions. The magnitude of threats as compared to current conditions are projected to increase as described above (Table 13). Potential impacts to resiliency, redundancy, and representation are discussed below.

Resiliency

Under Scenario 1 population resiliency is projected to decline from ongoing habitat loss and reduced occupancy. In this scenario, urban development is projected to increase by 25 percent throughout the range with the highest proportion of impact in the NAU, which does not have NCCPs or HCPs in place to help direct development away from important habitat areas. Wildfire and vegetation type conversion are also projected to increase, again with the highest impact occurring in the NAU. These factors result in the NAU remaining in low condition for habitat suitability and dropping from moderate to low condition in habitat quantity. For connectivity, the current average amount of suitable habitat in a 30 km (18.6 mi) radius is 5 percent, just above the threshold for a moderate condition score, indicating that connectivity is already somewhat compromised. Given the predicted effects on habitat suitability and quantity, and being so close to the moderate condition threshold, we assume connectivity would also drop to a low condition, in part because the habitat in this area is not being preserved in a core-and-linkage manner. Overall, the NAU is predicted to drop from its current moderate condition to a low habitat condition. Since the NCAU is already mostly developed and contains such a small quantity of habitat in its current condition, we don’t expect large changes, and it would remain in low habitat condition. The MCAU is well above the thresholds defined for our habitat conditions and thus has a larger "margin of safety" and therefore remains in high condition for all habitat condition categories. The MIAU, while containing a large amount of habitat, does not have high habitat suitability; therefore, habitat quantity remains in high condition and suitability remains in low condition. Although hard to predict, connectivity in the MIAU is currently just above the threshold to be considered moderate (current condition is 7 percent suitable habitat in a 30 km (18.6 mi) buffer) and may be reduced to a low condition under Scenario 1 conditions, especially with the increase of development, fires, and vegetation type conversion. In the SAU, habitat quantity would be reduced to a moderate condition while habitat suitability and connectivity would remain in moderate and high condition, respectively. Overall, the rangewide habitat conditions for Scenario 1 would be low to moderate with one analysis units in high condition (MCAU), one in moderate/high condition (SAU), one in low/moderate condition (MIAU), and two in low condition (NAU, NCAU) (Table 18).

In Scenario 1, the additional loss of habitat from increased development and wildfire-induced vegetation type conversion are anticipated to result in lower occupancy rates, especially in the NAU and NCAU where habitat conditions are projected to be low. Lower occupancy and decreased quantity of available suitable habitat in the northern portion of the range would reduce the ability of the environment to support gnatcatchers and result in a smaller census population in that area. This may result in the overall effective population size decreasing to a level insufficient for maintaining long term genetic fitness (less than 1,000), but the amount of remaining habitat in the MIAU, MCAU, and SAU would likely be sufficient to support an effective population size large enough to avoid inbreeding depression (greater than 100), thus retaining a moderate condition for effective population size. Decreased occupancy in the NAU and NCAU would result in moderate condition for occupancy rangewide. Overall, the condition of demographic factors for the coastal California gnatcatcher under Scenario 1 would be moderate.

To summarize, rangewide habitat conditions in Scenario 1 would be reduced from moderate under current conditions to a low/moderate condition and demographic factors would be reduced from a moderate/high condition to a moderate condition. Therefore, population resiliency under Scenario 1 is predicted to be low/moderate indicating the subspecies would likely be able to withstand environmental stochasticity over the next 50 years but at a reduced margin of safety.

Redundancy

Under Scenario 1, with projected loss of occupied areas, we consider the coastal California gnatcatcher to have decreased redundancy to withstand catastrophic events as compared to current condition. In this scenario, the condition of the NAU, MIAU, and SAU are likely to decrease due to reduced habitat quantity, suitability, and connectivity from increased stressors (urban development, wildland fire, vegetation type conversion; Table 18, Table 19, Figure 29). The NCAU would remain in low condition. The remaining unit (MCAU) is projected to maintain its current level of condition/resiliency despite some loss of suitable habitat from development and wildfire. Additionally, in areas where the subspecies is covered by NCCP/HCPs, we predict that development will be directed away from areas of higher quality suitable habitat. Despite reductions in the amount of occupied habitat, the subspecies is likely to be able to withstand catastrophic events over the next 50 years, such as potential adverse impacts due to wildfire and vegetation type conversion.

Representation

Under Scenario 1, the subspecies may see a decrease in adaptive capacity from losses of occupied habitat along the northern boundary of the subspecies' range, specifically in the NAU. Loss of suitable habitat to urban development, wildfire and vegetation type conversion could result in a contraction of the northern extent of the range over the next 50 years. Such losses would be likely to erase the apparent increases in gnatcatcher occupancy and expanding distribution seen in this part of the subspecies' range in recent years. Moreover, such losses would be likely to reduce the gnatcatcher's adaptive capacity because this part of the subspecies' range may be important for climate-induced range shifts. As discussed in the *Genetics* section, birds in this area appear to express differences in climate-adapted loci associated with greater extremes of temperature and precipitation. Therefore, losses in the northernmost portion of the range could result in a significant loss of genetic diversity, especially if the birds in this area are more adept at dealing with potential range shifts due to climate change. Additionally, decreased occupancy and loss of individuals from the NAU could contribute to a reduction in the subspecies effective population size. While difficult to determine how appreciably the effective population size may be affected, it could be reduced to a level below the recommended size for maintaining adaptive capacity over the long term. Therefore, losses at the northern boundary of the range would likely result in reduced representation, decreasing the ability of the gnatcatcher to adapt to changing environmental conditions in the future. Additionally, the infusion of genes from gnatcatchers dispersing from Baja California would be restricted by the barrier formed by the Tijuana urbanization zone. Immigration-related gene flow from the naturally warmer climate in Mexico may be important for maintaining adaptive capacity as the climate in Southern California warms.

7.3 Scenario 2

Scenario 2 is based on an RCP 4.5 emissions scenario under warmer and wetter conditions. The magnitude of threats as compared to current conditions are projected to increase as described above (Table 13). Potential impacts to resiliency, redundancy, and representation are discussed below.

Resiliency

Under Scenario 2, population resiliency may be slightly reduced due to reduced habitat conditions and reduced occupancy. In this scenario, urban development increases approximately 20 percent throughout the range and wildfire is projected to increase slightly, but to a lesser degree than in Scenario 1. Additionally, the risk of fire burning the same area two or more times (increased risk of vegetation type conversion) is projected to remain the same as the baseline period (1981–2020). Like Scenario 1, the NAU was projected to have the largest impacts from urban development and fire. In our analysis, the NAU has a low condition for habitat suitability and connectivity, and a moderate condition for habitat quantity. This results in a drop from the current overall moderate condition to a low condition. The NCAU, like its current condition and the condition in Scenario 1, remains low. The MCAU, while projected to have a decrease in habitat quantity, remains in high condition for all habitat factors. The MIAU remains in high condition for habitat quantity with low condition for suitability. Connectivity will likely decline from moderate to low condition due to the projected increase of rains, which was the greatest driver of reduced habitat suitability according to modeling discussed in the *Climate Change and the Coastal California Gnatcatcher* section, above. The SAU is projected to remain in high condition for quantity and connectivity, and moderate condition for suitability. Overall, the rangewide habitat conditions for Scenario 2 would be moderate with two units in high condition (MCAU and SAU), one in moderate condition (MIAU), and two in low condition (NAU and NCAU) (Table 20).

Table 18. Scenario 1 habitat conditions by analysis unit and overall.[1]

Geographic Analysis Unit	Habitat Suitability	Habitat Quantity	Connectivity	Overall Condition of Habitat Needs
NAU	Low	**Low[2]**	Low	**Low[2]** (current condition = moderate)
NCAU	Low	Low	Low	Low
MCAU	High	High	High	High
MIAU	Low	High	**Low/Moderate[2]**	**Low/Moderate[2]** (current condition = moderate)
SAU	Moderate	**Moderate[2]**	High	**Moderate/High[2]** (current condition = high)
Rangewide Habitat Condition	Low	Moderate	Moderate	**Low/Moderate[2]** (current condition = moderate)

[1] Bolded text indicates a change from current condition.
[2] Changed.

Table 19. Scenario 1 Demographic Factor Conditions.[1]

Effective Population Size	Occupancy	Overall Condition of Demographic Needs
Moderate	**Moderate[2]**	**Moderate[2]** (current condition = moderate/high)

[1] Bolded text indicates a change from current condition.
[2] Changed.

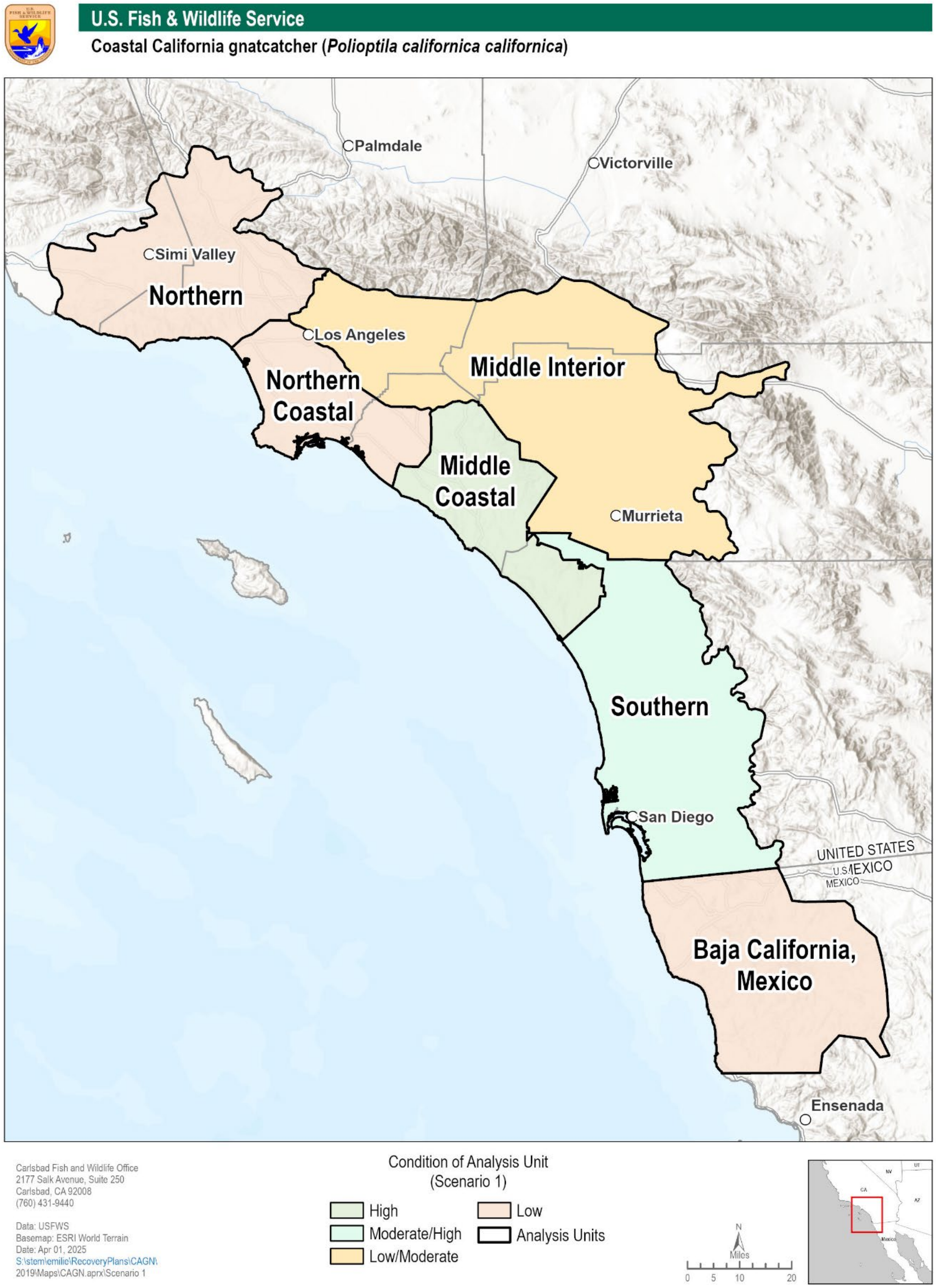

Figure 29. Coastal California gnatcatcher geographic analysis units displaying the Scenario 1 conditions of habitat needs.

For demographic factors, occupancy is likely to be reduced, especially in the NAU where increased development and fires are projected to have the largest impact. Having two AUs in low condition is also likely to reduce the effective population size to a level insufficient for long term genetic fitness (less than 1,000). Overall, demographic factors would decline from a moderate/high condition to a moderate condition (Table 21).

To summarize, rangewide, habitat conditions in Scenario 2 would remain in a moderate condition and demographic factors would likely drop from a moderate/high condition to a moderate condition. Therefore, population resiliency under Scenario 2 is predicted to be moderate indicating the probability of persistence may be compromised by the lack of one or more needs but the subspecies is likely to maintain the ability to withstand environmental and demographic stochasticity over the next 50 years (Table 20, Table 21, Figure 30).

Redundancy

While it is unlikely that an entire analysis unit would be extirpated under Scenario 2, redundancy of the coastal California gnatcatcher is reduced as compared to current conditions from ongoing habitat loss. Reduced habitat conditions and occupancy, especially in the NAU and NCAU, lowers the ability for gnatcatchers in those units to recover from catastrophic events, should they occur. Since the NAU and NCAU are already somewhat isolated from the other units, recolonization may be slow to occur. Additionally, increased precipitation, a main factor limiting the distribution of gnatcatchers, is projected to increase in this scenario which may decrease suitable habitat and further reduce connectivity. Despite reductions in the amount of occupied habitat, the subspecies is likely to be able to withstand catastrophic events over the next 50 years, such as potential adverse impacts due to wildfire and vegetation type conversion.

Representation

Under Scenario 2, adaptive capacity may decrease slightly compared to current conditions due to reduced habitat conditions and occupancy in the NAU. Losses at the subspecies boundary would result in a contraction of the range, leading to decreases in population-level genetic and habitat diversity, especially if the birds in this area are more adept to dealing with potential range shifts due to climate change. Therefore, reduced occupancy and loss of individuals from NAU may represent a loss in adaptive capacity for climate change. Additionally, the reduced effective population, while likely to remain large enough to reduce inbreeding depression, would likely be reduced to level insufficient for long term adaptive capacity. Therefore, losses at the northern portion of the range could result in reduced representation, decreasing the ability of the gnatcatcher to adapt to changing environmental conditions in the future.

Table 20. Scenario 2 habitat conditions by analysis unit and overall.[1]

Geographic Analysis Unit	Habitat Suitability	Habitat Quantity	Connectivity	Overall Condition of Habitat Needs
NAU	Low	**Low**[2]	Low	**Low**[2] (current condition = moderate)
NCAU	Low	Low	Low	Low
MCAU	High	High	High	High
MIAU	Low	High	**Low/Moderate**[2]	Moderate
SAU	Moderate	High	High	High
Rangewide Habitat Condition	Low	High	Moderate	Moderate

[1] Bolded text indicates a change from current condition.
[2] Changed.

Table 21. Scenario 2 demographic factor conditions. [1]

Effective Population Size	Occupancy	Overall Condition of Demographic Needs
Moderate	**Moderate**[2]	**Moderate** (current condition = moderate/high)

[1] Bolded text indicates a change from current condition.
[2] Changed.

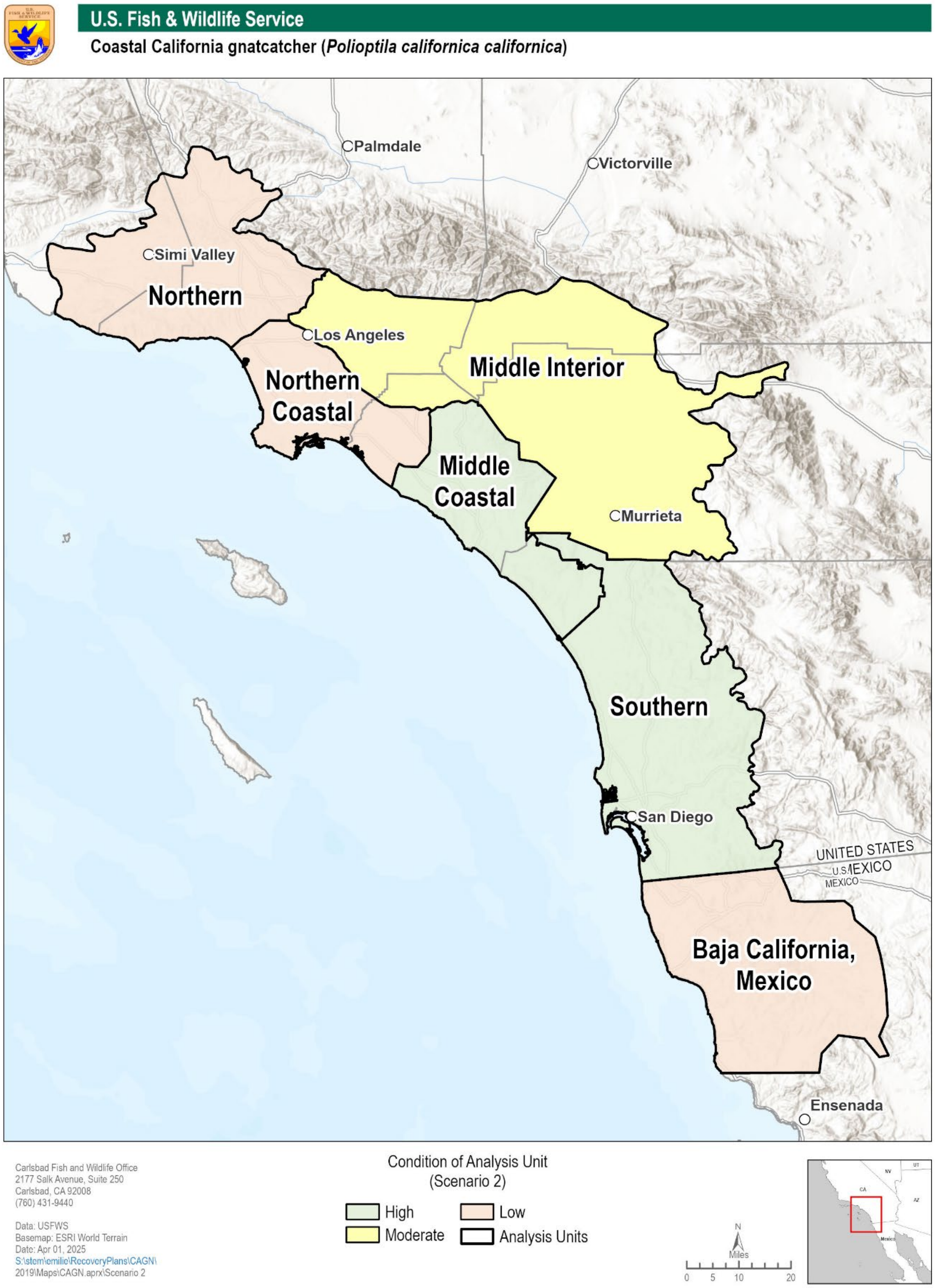

Figure 30. Coastal California gnatcatcher geographic analysis units displaying the Scenario 2 conditions of habitat needs.

CHAPTER 8 - OVERALL SYNTHESIS AND SUMMARY OF SCENARIOS W/ 3R DISCUSSION

This SSA describes the current condition for the coastal California gnatcatcher, and the subspecies' future condition under two plausible future scenarios over the next 50 years. For these analyses, we delineated six analysis units encompassing the subspecies' current range. For the purposes of this SSA report, we reduced the subspecies' current range, delineating its southern extent at 32 degrees north latitude rather than 30 degrees north latitude as suggested by new information. We assessed the existing threats and stressors relative to the gnatcatcher's needs. We further considered the conservation efforts that may be reducing the magnitude of these threats. Many existing and ongoing threats are being reduced to some extent, especially in certain geographical areas, because of implementation of the Act and the State's NCCP Act.

Under the current condition for habitat in the gnatcatcher's range, two analysis units have high resiliency, two have moderate resiliency, and two have low resiliency. In general, gnatcatchers are distributed widely throughout the range, are fairly well connected (except in the north and at certain isolated populations), and are maintaining a high effective population size, demonstrating redundancy and representation, although some adaptive capacity may be compromised by reduced geneflow in the northern and southern extents of its range.

In our future scenarios, we forecast the future viability of the species by predicting the responses of our analysis unit conditions under two scenarios extending 50 years into the future. We chose 50 years because the likelihood and severity of future threats become more uncertain beyond that timeframe. Additionally, under the NCCP/HCP process, cooperating jurisdictions have established long-term regional planning efforts within the range of the coastal California gnatcatcher. These plans are permitted for 50 to 75 years, depending on plan terms and conditions. Some plans have been operating for more than 20 years, while others are still being negotiated. Therefore, a 50-year timeframe provided balance to predict the scope of impacts, and the certainty of impacts considered. Due to lack of information, we are unable to project the future condition of the BCAU; therefore, our future scenario analysis did not include Baja California.

In the future condition analysis, we assessed two plausible future scenarios to encompass a range of likely conditions impacting the habitat and demographic conditions of the coastal California gnatcatcher to determine its resiliency. In Scenario 1, projected increases in development, wildfire, and vegetation type conversion are likely to reduce habitat conditions across all analysis units, but especially in the NAU and MIAU where habitat suitability and connectivity are currently low and just barely moderate, respectively. Additionally, most of the suitable habitat in these units is not currently considered conserved. Therefore, the habitat conditions for each unit in Scenario 1 are one analysis unit in high condition (MCAU), one in moderate/high condition (SAU), one in low/moderate condition (MIAU), and two in low condition (NAU and NCAU), resulting in an overall low/moderate habitat condition. In Scenario 2, the NAU condition is reduced, and the other units remain the same as current conditions. Therefore, the habitat conditions for each unit in Scenario 2 are two analysis units in high condition (MCAU and

SAU), one in moderate condition (MIAU), and two in low condition (NAU and NCAU), resulting in an overall moderate habitat condition (Table 22, Figure 31).

For demographic factors, it is likely that reductions in habitat conditions would result in reduced occupancy in parts of the range which would then influence the effective population size. Although it is difficult to quantify, the current effective population size is very close to the threshold for maintaining long term adaptive capacity; therefore, it is likely any reductions in effective population may result in dropping below that recommended threshold. Again, the greatest impacts are likely to be seen at the boundaries of the species range (NAU and MIAU), which according to genetic analysis, may contain individuals expressing genetic changes that may be beneficial for climate change adaptations. Although it is unlikely that an entire analysis unit would be extirpated, if birds are lost or extirpated from areas within these AUs, it would further reduce the adaptive capacity of the subspecies. In both scenarios, the demographic condition drops from a moderate/high to moderate condition (Table 23).

When compared to current conditions, our assessment of future conditions for the coastal California gnatcatcher showed a reduction in resiliency to a low/moderate condition in Scenario 1 and a maintained level of moderate resiliency in Scenario 2. Overall, both scenarios revealed the greatest impacts occurring in the northern analysis units (NAU and MIAU). Anticipated reductions in habitat conditions from increased threats (urban development, wildland fire, and vegetation type conversion) result in decreased redundancy and representation of the subspecies. There was also a decrease in demographic conditions (occupancy and effective population size) for the gnatcatcher across both scenarios. In summary, conditions in Scenario 1 indicate that the probability of persistence over the next 50 years for the costal California gnatcatcher is compromised because of threats acting on the subspecies and its habitat, especially in the NAU, NCAU, and MIAU. Conditions in Scenario 2 indicate the probability of persistence may be compromised by the lack of one or more needs—again, especially in the northernmost portion of the range, but the subspecies is likely to maintain the ability to withstand environmental and demographic stochasticity over the next 50 years (Table 24).

Table 22. Future scenario comparison table for habitat factors.[1]

Geographic Analysis Unit	Current Condition	Scenario 1	Scenario 2
NAU	Moderate	Low	Low
NCAU	Low	Low	Low
MCAU	High	High	High
MIAU	Moderate	Low/Moderate	Moderate
SAU	High	Moderate/High[2]	High
Baja California, Mexico AU	Low (likely)	Low (likely)	Low (likely)
Rangewide Habitat Condition	Moderate	Low/Moderate	Moderate

Table 23. Future scenario comparison table for demographic factors.

Demographic Factor	Current	Scenario 1	Scenario 2
Effective Population Size	Moderate	Moderate	Moderate
Occupancy	High	Moderate	Moderate
Overall Condition of Demographic Needs	Moderate/High	Moderate	Moderate

Table 24. Future scenario comparison table for overall population resiliency.

Population scale	Current	Scenario 1	Scenario 2
Habitat condition	Moderate	Low/Moderate	Moderate
Demographic condition	Moderate/High	Moderate	Moderate
Population resiliency	Moderate/High	Low/Moderate	Moderate

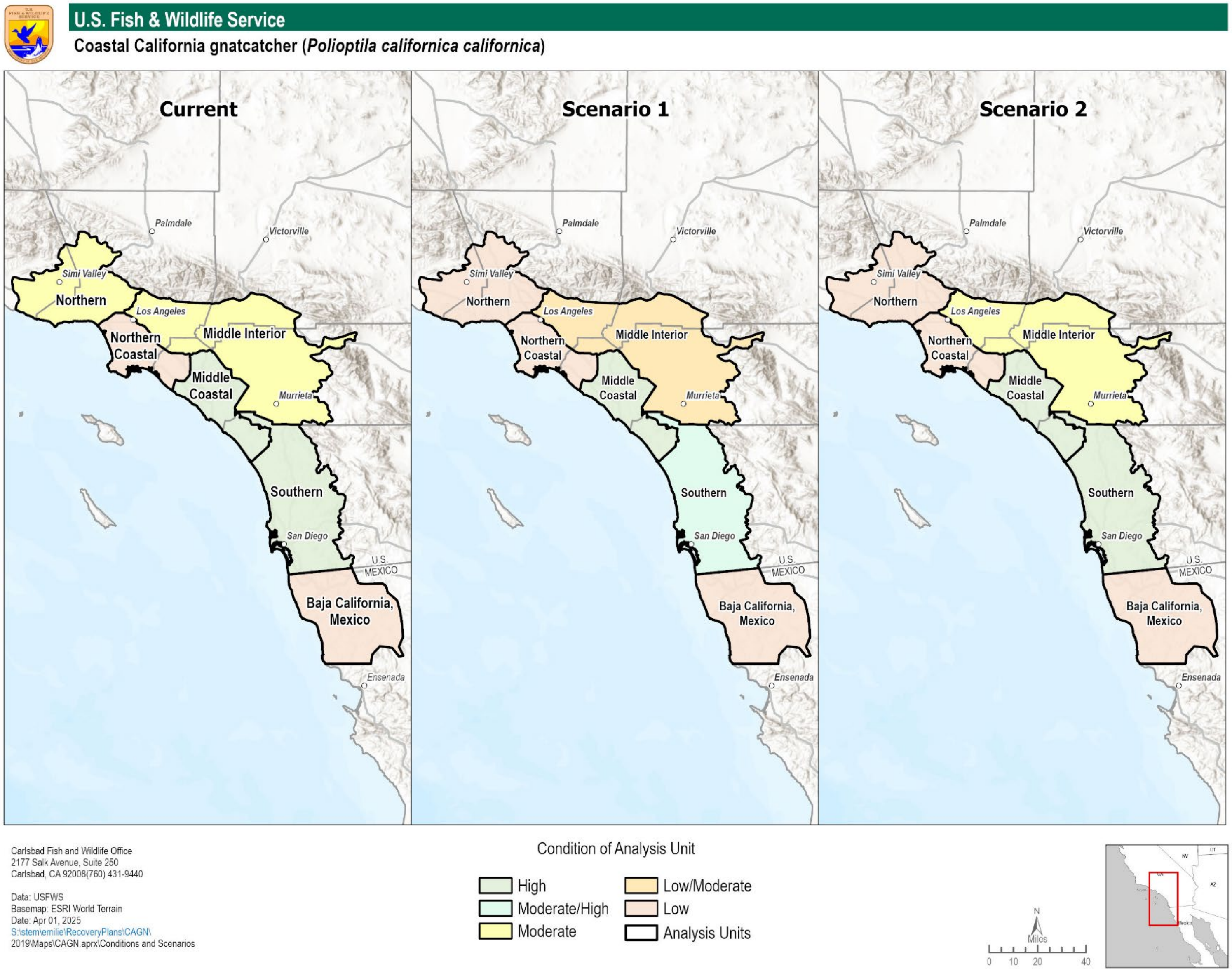

Figure 31. Coastal California gnatcatcher analysis units displaying current and two future scenarios for habitat conditions.

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APPENDIX A

EXISTING REGULATORY MECHANISMS

Existing regulatory mechanisms that affect the coastal California gnatcatcher include laws and regulations promulgated by Federal and State governments in the United States and in Mexico. In relation to Factor D under the Act, we consider relevant Federal, State, and Tribal laws, regulations, and other such mechanisms that may minimize any of the threats we describe under the other four factors, or otherwise enhance conservation of the species. We give strongest weight to statutes and their implementing regulations and to management direction that stems from those laws and regulations; an example would be State governmental actions enforced under a State statute or constitution, or Federal action under statute. For currently listed species, we consider the adequacy of existing regulatory mechanisms to address threats to the species absent the protections of the Act. Potential threats acting on the coastal California gnatcatcher for which governments may have regulatory control include impacts associated with urban and agricultural development, vegetation type conversion, wildland fire, climate change, and brood parasitism.

Federal Mechanisms

National Environmental Policy Act (NEPA) All Federal agencies are required to adhere to the NEPA of 1970 (42 U.S.C. 4321 et seq.) for projects they fund, authorize, or carry out. Prior to implementation of such projects with a Federal nexus, NEPA requires the agency to analyze the project for potential impacts to the human environment, including natural resources. However, NEPA does not impose substantive environmental obligations on Federal agencies—it merely prohibits an uninformed agency action. Although NEPA requires full evaluation and disclosure of information regarding the effects of contemplated Federal actions on sensitive species and their habitats, it does not by itself regulate activities that might affect the coastal California gnatcatcher; that is, effects to the subspecies and its habitat would receive the same scrutiny as other plant and wildlife resources during the NEPA process and associated analyses of a project's potential impacts to the human environment.

Endangered Species Act of 1973, as Amended (Act)

Upon its listing as threatened, the coastal California gnatcatcher benefited from the protections of the Act, which include the prohibition against take and the requirement for interagency consultation for Federal actions that may affect the species. Section 9 of the Act and Federal regulations prohibit the take of endangered and threatened species without special exemption. The Act defines ''take'' as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct (16 U.S.C. 1532(19)). Our regulations define ''harm'' to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Our regulations also define ''harass'' as intentional or negligent actions that create the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavior patterns, which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3).

Section 7(a)(1) of the Act requires all Federal agencies to utilize their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation of endangered species and threatened species. Section 7(a)(2) of the Act requires Federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species or destroy or adversely modify their critical habitat. Because the Service has regulations that prohibit take of all threatened wildlife species (50 CFR 17.31(a)), unless modified by a rule issued under section 4(d) of the Act (50 CFR 17.31(c)), the regulatory protections of the Act are largely the same for wildlife species listed as endangered and as threatened.

A section 4(d) rule for the coastal California gnatcatcher was published on December 10, 1993 (58 FR 65088). Under that rule, incidental take of the coastal California gnatcatcher is not considered to be a violation of section 9 of the Act if the take results from activities conducted pursuant to the NCCP Act of 1991 and in accordance with an approved NCCP plan, provided that the Service determines that such a plan meets the issuance criteria of an ''incidental take'' permit pursuant to section 10(a)(2)(B) of the Act and 50 CFR 17.32(b)(2). Under the section 4(d) rule, a limited amount of incidental take of the coastal California gnatcatcher within subregions actively engaged in preparing a NCCP plan will also not be considered a violation of section 9 of the Act, provided the activities resulting in such take are conducted in accordance with the NCCP Conservation Guidelines and Process Guidelines. Under section 10(a)(1)(B) of the Act, the Service may issue permits authorizing the incidental take of federally listed animal species. Incidental take permittees must develop and implement a habitat conservation plan (HCP) that minimizes and mitigates the impacts of take to the maximum extent practicable and that avoid jeopardy to listed species. Incidental take permits are available to private landowners, corporations, Tribal governments, State and local governments, and other non-Federal entities. These permits can reduce conflicts between endangered species and economic activities and develop important partnerships between the public and private sectors. As discussed in the Urban and Agricultural Development section above, we have issued incidental take permits for regional HCP and NCCP/HCPs covering approximately 44 percent of modeled gnatcatcher habitat, and two additional NCCP/HCPs are nearing completion.

Since 1993, the Service has addressed impacts to the coastal California gnatcatcher from urban development and other projects outside of the NCCP/HCP regional planning effort through the section 7 process. The projects have included residential and commercial developments, highway-widening projects, and pipeline projects, among others. Section 7 consultations have also been conducted with the U.S. Army Corps of Engineers for Clean Water Act permit applications, and other Federal agencies on specific actions. In addition to ''projects,'' we have consulted with the U.S. Marine Corps to address potential impacts to the gnatcatcher and its habitat from military training activities on Marine Corps Base Camp Pendleton (Camp Pendleton) and Miramar Corps Air Station (Miramar), and we have consulted with the U.S. Navy on actions related to the management of Naval Weapons Station Seal Beach Detachment Fallbrook (Detachment Fallbrook).

In all these consultations, we concluded that, due to the implementation of conservation measures to avoid, minimize, and offset impacts to the subspecies and its habitat, effects of the proposed actions were not likely to jeopardize the continued existence of the coastal California gnatcatcher and were not likely to result in the destruction or adverse modification of designated critical habitat for the subspecies. We will continue to evaluate impacts of proposed projects to the subspecies and its habitat for those areas outside of the NCCP/HCPs through other provisions of the Act, such as section 7 consultation, recovery implementation, and periodic status reviews.

Our evaluation confirms that urban development and associated threats continue for the coastal California gnatcatcher but listing of the coastal California gnatcatcher under the Act as threatened has provided protection to the subspecies and its habitat, including the prohibition against take and the conservation mandates of section 7 for all Federal agencies.

Sikes Act

The Sikes Act (16 U.S.C. 670a–670f, as amended) directs the Secretary of Defense, in cooperation with the Service and State fish and wildlife agencies, to carry out a program for the conservation and rehabilitation of natural resources on military installations. The Sikes Act Improvement Act of 1997 (Pub. L. 105–85) broadened the scope of military natural resources programs, integrated natural resources programs with operations and training, embraced the tenets of conservation biology, invited public review, strengthened funding for conservation activities on military lands, and required the development and implementation of an Integrated Natural Resources Management Plan (INRMP) for relevant installations, which are reviewed every 5 years.

INRMPs incorporate, to the maximum extent practicable, ecosystem management principles, provide for the management of natural resources (including fish, wildlife, and plants), allow multipurpose uses of resources, and provide public access necessary and appropriate for those uses without a net loss in the capability of an installation to support its military mission. An INRMP is an important guidance document that helps to integrate natural resource protection with military readiness and training. In addition to technical assistance that the Service provides to the military, the Service can enter into interagency agreements with installations to help implement an INRMP. The INRMP implementation projects can include wildlife and habitat assessments and surveys, fish stocking, exotic species control, and hunting and fishing program management.

On Department of Defense lands, including Camp Pendleton, Detachment Fallbrook, and Miramar, coastal California gnatcatcher habitat is generally not subjected to threats associated with large-scale development. However, the primary purpose for military lands, including most gnatcatcher habitat areas, is to provide for military support and training. At these installations, INRMPs provide direction for project development and for the management, conservation, and rehabilitation of natural resources, including for the subspecies and its habitat. For example, on Camp Pendleton and MCAS Miramar, management measures that benefit the coastal California gnatcatcher and its habitat include nonnative vegetation control, nonnative animal control, and habitat enhancement and restoration (MCB Camp Pendleton 2007, p. F–25; MCAS Miramar INRMP 2010, pp. 7–18–7–19). Some restrictions on training and construction activities also apply during gnatcatcher breeding season to reduce impacts on nesting gnatcatchers (MCB Camp Pendleton 2007, p. F–25; MCAS Miramar INRMP 2010, pp. 7–18–7–19).

Without the protections provided to the subspecies and its habitat under the Act (that is, if the coastal California gnatcatcher was delisted), there would be less incentive for the Marine Corps or Navy to continue to include specific provisions (for example, monitoring) in their INRMPs to provide conservation benefits to the subspecies, beyond that provided under a more general integrated natural resource management strategy at these and other DOD installations. Specific information on each installation is listed below.

Camp Pendleton Marine Corps Base and Detachment Fallbrook

The Marine Corps Base Camp Pendleton (MCBCP) and Detachment Fallbrook is composed of Department of Defense (DoD) lands. It is approximately 134,284 ac (54,342 ha) with 113,534 ac (45,945 ha) of modeled gnatcatcher habitat. Of the modeled gnatcatcher habitat, 70 percent is high or very high quality. Although the Camp Pendleton/Fallbrook subunit is not addressed by NCCP/HCP plans, actions that adversely affect listed species, including the gnatcatcher, are addressed via section 7 of the Act and the Sikes Act. Additionally, these areas each have an INRMP that provides benefits for the gnatcatcher and works to support and complement local and regional conservation efforts. Management of coastal California gnatcatchers through the INRMP includes monitoring surveys, cowbird trapping, habitat restoration and post-fire recovery studies (USMC 2018, p. 4-5, N-44). MCBCP makes an important contribution by providing an integral open-space linkage of habitat preserved in neighboring NCCP/HCPs.

Miramar

Marine Corps Air Station Miramar and is comprised of all DoD lands. It is approximately 22,892 (9,264 ha) with 14,316 ac (5,793 ha) of modeled gnatcatcher habitat. Like the Camp Pendleton/Fallbrook subunit, the Miramar subunit is not addressed by the NCCP/HCP plans, but it is covered by an INRMP that provides benefits to the gnatcatcher. Additionally, actions that may adversely affect the gnatcatcher are subject to section 7 consultation via the ACT and the Sikes Act. Management of coastal California gnatcatchers through the INRMP includes habitat evaluations, monitoring surveys, and participation in the Readiness and Environmental Protection Integration Program (REPI). The REPI Program allows the DoD to assist with the purchase of land easements used to preserve habitat and relieve restrictions on military activities.

State Laws Affecting the Coastal California Gnatcatcher

The coastal California gnatcatcher is designated as a Species of Special Concern by the California Department of Fish and Wildlife (CDFW) (CDFG 2008). Although this designation is administrative and provides no formal legal status for protection, it is intended to highlight those species at conservation risk to State and Federal and local governments, land managers, and others, as well as to encourage research for those species whose life history and population status are poorly known (Comrack *et al.* 2008, p. 2).

California Environmental Quality Act (CEQA)

CEQA (California Public Resources Code 21000–21177) is the principal statute mandating environmental assessment of projects in California. The purpose of CEQA is to evaluate whether a proposed project may have an adverse effect on the environment and, if so, to determine whether that effect can be reduced or eliminated by pursuing an alternative course of action, or through mitigation. CEQA applies to certain activities of State and local public agencies; a public agency must comply with CEQA when it undertakes an activity defined under CEQA as a ‘‘project.’’

As with NEPA, CEQA does not provide a direct regulatory role for the CDFW or other State and local agencies relative to activities that may affect the coastal California gnatcatcher. However, CEQA requires a complete assessment of the potential for a proposed project to have a significant adverse effect on the environment. Among the conditions outlined in the CEQA Guidelines that may lead to a mandatory finding of significance are where the project ‘‘has the potential to . . . substantially reduce the habitat of a fish or wildlife species; cause a fish or wildlife population to drop below self-sustaining levels; threaten to eliminate a plant or animal community; [or] substantially reduce the number or restrict the range of an endangered, rare or threatened species’’ (title 14 of the California Code of Regulations (CCR), § 15065(a)(1)). The CEQA Guidelines further state that a species ‘‘not included in any listing [as threatened or endangered] shall nevertheless be considered to be endangered, rare, or threatened, if the species can be shown to meet the criteria’’ for such listing (14 CCR 15380(d)). In other words, CEQA would require any project that may impact populations of these species to assess and disclose such potential impacts during the environmental review process (Osborn 2015, pers. comm.).

The Natural Community Conservation Planning (NCCP) Act

The NCCP program is a cooperative effort between the State of California and numerous private and public partners with the goal of protecting habitats and species. The NCCP program identifies and provides for the regional or area-wide protection of plants, animals, and their habitats while allowing compatible and appropriate economic activity. The program uses an ecosystem approach to planning for the protection and continuation of biological diversity (https://www.wildlife.ca.gov/Conservation/Planning/NCCP). Regional NCCPs provide protection to federally listed and other covered species by conserving native habitats upon which the species depend. NCCPs are usually developed in conjunction with habitat conservation plans (HCPs) prepared pursuant to the Act.

The NCCP Act addresses certain habitat areas or “regions.” Implementation of the NCCP/HCP process resulted in the development of NCCP/HCP plans that addressed impacts to numerous species including the gnatcatcher and its habitat throughout much of its U.S. range. Regional NCCP/HCP plans include funding mechanisms to provide for habitat acquisition, species monitoring, and adaptive management. In contrast to the voluntary actions outlined in recovery plans, NCCP/HCP plans, which are prepared in collaboration with the permittees, include mandatory permit requirements. As such, the NCCP/HCP plans and associated permits provide greater assurances that measures specifically contributing to the recovery of the gnatcatcher will be implemented.

The following NCCP plans that cover the coastal California gnatcatcher are currently approved and being implemented: San Diego Multiple Habitat Conservation Program (one of four Subregional Plans in San Diego County with 1 of 6 Subarea Plans approved), San Diego County: Multiple Species Conservation Program (a second Subregional Plan in San Diego County with 12 participating jurisdictions), San Diego County Water Authority NCCP/HCP, San Diego Gas & Electric NCCP, , Orange County Central/Coastal NCCP/HCP, Orange County Transportation Authority NCCP/HCP, Western Riverside County Multiple Species Habitat Conservation Plan (Western Riverside County MSHCP), Upper Santa Ana River Wash Habitat Conservation Plan, Los Angeles County: Rancho Palos Verdes NCCP/HCP. the North County MSCP plan is in development. In addition, the Orange County Southern Subregion HCP is not approved as an NCCP, but this plan is a regionally significant Service-approved HCP that includes core populations of the coastal California gnatcatcher and large expanses of coastal sage scrub.

These plans provide a comprehensive, habitat-based approach to the protection of covered species, including the coastal California gnatcatcher, by focusing on lands identified as important for the long-term conservation of the covered species and through the implementation of management actions for conserving those lands. These protections are outlined in the management actions and conservation objectives described within each plan. However, because the total habitat protection associated with these plans is not expected until plans are fully implemented, and because not all areas are covered, habitat loss is still impacting the gnatcatcher and is expected to continue into the future.

We estimate 44 percent of the U.S. range of the gnatcatcher is currently in areas covered by approved NCCP/HCPs. When all draft NCCP/HCPs are finalized, that estimate will increase to 53 percent. Details on NCCP/HCPs within the range of the gnatcatcher are listed below (Figure 31).

San Diego MHCP

The San Diego MHCP encompasses the cities of Carlsbad, Encinitas, Escondido, Oceanside, San Marcos, Solana Beach, and Vista in northwestern San Diego County. It is approximately 117,195 ac (47,427 ha) with approximately 27,098 ac (10,966 ha) of modeled gnatcatcher habitat. The MHCP is an umbrella plan for the area, and each subarea jurisdiction prepares its own Subarea Plan to implement the MHCP within that jurisdiction under a 50-year permit. Once implemented, conservation areas within the MHCP will be preserved in a core-and-linkage configuration and managed in perpetuity (USFWS 2004a, p. 206). Currently, the City of Carlsbad is the only jurisdiction with an approved Subarea Plan.

San Diego MSCP

The San Diego Multiple Species Conservation Program encompasses 12 jurisdictions in southwestern San Diego County. It is approximately 528,131 ac (213,727 ha) with approximately 187,468 ac (75,865 ha) of modeled gnatcatcher habitat. Similar to the San Diego

MHCP, it is an umbrella plan for the area in which each jurisdiction, or subarea, prepares its own Subarea Plan to implement the MSCP within that jurisdiction under a 50-year permit. Once implemented, the conservation areas will be preserved in a core-and-linkage configuration and managed in perpetuity (USFWS 1997, pp. 68–69). Currently, 5 of 11 subarea plans are approved.

North County MSCP Plan

The North County MSCP plan is approximately 329,578 ac (133,375 ha) with approximately 132,179 ac (53,491 ha) of modeled gnatcatcher habitat. The MSCP is under the umbrella of the San Diego MSCP and is still in development. However, the conservation reserve design has been completed and takes established critical habitat areas for the gnatcatcher into account. The plan will also aim to conserve areas in a core and linkage formation. Additionally, this area is subject to a county ordinance the covers CSS habitat and requires mitigation if a project does come forward but there is no commitment to long-term management.

Orange County Central Coastal NCCP/HCP

The Orange County Central Coastal NCCP/HCP covers approximately 208,583 ac (84,410 ha) of area throughout the central portion of Orange County. The area extends from the pacific coastline inland to the Riverside County and is bound by State Route 91 to the west and El Toro Road and Interstate 5 to San Juan Creek on the east (County of Orange 1996, p. ES-3–ES-4). The plan was approved in 1996 with a 75-year permit and preserves 37,378 ac (15,126 ha) of various habitat types. It contains approximately 71,323 ac (28,863 ha) of modeled gnatcatcher habitat; of which, 56 percent is high or very high quality, The plan lists the coastal California gnatcatcher as a focal species and areas conserved through implementation of the NCCP/HCP will be preserved in a core-and-linkage configuration and managed in perpetuity (USFWS 1996, p. 43). The plan also implements an adaptive management program to benefit the gnatcatcher that includes monitoring surveys, habitat enhancement, and pest/invasive species control (USFWS 1996, p.48). Of the total modeled gnatcatcher habitat, 74 percent is currently conserved.

Orange County Southern Subregion HCP

The Orange County Southern Subregion HCP encompasses the southern portion of Orange County east of the 5 freeway and south of El Toro Road through the Forest Service lands in the southeast of the county. The area is approximately 131,776 ac (53,327 ha) with 55,101 ac (22,298 ha) of modeled gnatcatcher habitat. Of the modeled habitat, 58 percent is considered high or very high quality. The Southern Subregion HCP lists the California gnatcatcher as a focal species and has an objective to conserve 80 percent of the California gnatcatcher population located in lands around Chiquita Canyon (USFWS 2007b). The areas conserved will be preserved in a core-and-linkage configuration and will be managed in perpetuity (USFWS 2007b). of the total modeled gnatcatcher habitat, 79 percent is currently conserved.

Western Riverside County MSHCP

The portion of the Western Riverside County MSHCP within the range of the gnatcatcher includes Riverside County west of the San Jacinto Mountains and into the San Gorgonio Pass. It is approximately 938,550 ac (379,817 ha) with approximately 394,862 ac (159,794 ha) of modeled gnatcatcher habitat, which is listed as a focal species of the MSHCP. The plan was permitted in June 2004 and areas conserved through implementation of the NCCP/HCP will be preserved in a core-and-linkage configuration and managed in perpetuity (USFWS 2004b, pp. 198, 204). The MSHCP includes species-specific objectives for the gnatcatcher that includes regular monitoring surveys and confirmation of distribution and successful reproduction (defined as a nest that produces at least one fledgling) within at least 75 percent of specified Core Areas once every three years. Since monitoring began in 2008, the distribution and reproduction of gnatcatchers in western Riverside has remained stable (Biological Monitoring Program 2019, p. 8). Currently, approximately 107,626 ac (43,554 ha) of the modeled gnatcatcher habitat within the area is conserved, and 91,581 ac (37,061 ha) is considered high/very high quality.

Rancho Palos Verdes NCCP/HCP

The Rancho Palos Verdes NCCP/HCP area encompasses the city of Rancho Palos Verdes located on the Palos Verdes Peninsula in southwestern Los Angeles County. It is approximately 8,614 ac (3,486 ha) with approximately 2,798 ac (1,132 ha) of modeled gnatcatcher habitat. The plan was permitted in November 2019 and lists the gnatcatcher as a focal species of the plan. The NCCP/HCP includes species-specific management actions for the gnatcatcher that includes regular monitoring to evaluate population dynamics, direct potential habitat restoration actions, and invasive species removal (Rancho Palos Verdes 2019, p. 113). In addition, implementation of the plan will provide a net increase of gnatcatcher habitat within the Rancho Palos Verdes Habitat Preserve.

In summary, while conservation is anticipated to continue within existing plan boundaries within the U.S. range of the coastal California gnatcatcher, habitat protection occurs in a stepwise fashion as areas are conserved, and the total habitat protection associated with a plan is not expected until plans are fully implemented. Once the plans are fully implemented upon completion of the permits (which last for 50–75 years), the plans would provide conservation for much of the 52 percent of the coastal California gnatcatcher’s range in the United States. However, the 43 percent of the subspecies’ range in Baja California is not subject to protections provided by NCCP/HCP plans. Therefore, the subspecies and its habitat remain susceptible to urban development and associated threats.

Without the protections provided to the subspecies and its habitat under the Act (that is, if the coastal California gnatcatcher was delisted), the current NCCP/HCPs may provide some ancillary benefits to the subspecies given that other federally listed species of plants and animals covered under these plans are also found within coastal sage scrub habitat (for example, Quino checkerspot butterfly (*Euphydrays editha quino*)). By continuing to implement the plans, the permittees would retain incidental take coverage for these other species. However, permittees under these regional plans could request permit modifications or request that their long-term permits be renegotiated should the coastal California gnatcatcher be delisted under the Act. Similarly, the NCCP/HCPs currently under development in Southern California would likely require reevaluation. However, all conservation already implemented would continue to provide benefits to the coastal California gnatcatcher even if it was delisted. Because conservation and management for the coastal California gnatcatcher has not yet been fully implemented under the NCCP/HCPs in place and some NCCP/HCPs are not yet developed, all the potential conservation anticipated under these plans is not yet fully assured absent the protections of the Act.

Regulatory Mechanisms in Mexico

As described above (see *Baja California* section), we recently estimated that approximately 685,583 ac (277,445 ha) of coastal sage scrub habitat remains in Baja California from 30°N. to the United States-Mexico border.

The *atwoodi* subspecies of the California gnatcatcher is recognized by the Mexican Government. Mellink and Rea (1994, p. 55) described it as ranging from Rio de las Palmas and Valle de las Palmas (30 km SE of Tijuana) in the interior and at least Punta Banda along the coast south to Arroyo El Rosario, 32 to 30 °N. The distribution of this taxon mostly overlaps with what the Service used to consider to be the southern part of the *californica* subspecies' range (58 FR 16742; March 30, 1993); however, as noted, we now consider the *californica* subspecies' range to extend only to 32°N latitude, which only slightly overlaps the *atwoodi* subspecies' range (Mellink and Rea 1994, p. 55).

This entity is listed as threatened under Mexico's NORMA Oficial Mexicana NOM–059–SEMARNAT–2010, Environmental Protection—Species of Wild Flora and Fauna Native to Mexico (Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo) (SEMARNAT 2010). Threatened species are defined under Mexican law as those which may be ''in danger of disappearing in the short or medium term'' if factors that adversely affect their viability, such as deterioration or modification of habitat, or directly reduce the size of their populations, continue to operate (SEMARNAT 2010, p. 5). However, enforcement of this law generally depends upon an individual or a groups' willingness to modify proposed projects rather than the legal protections provided under the law (Hinojosa 2008, pers. comm.). Monitoring of compliance with this law is the responsibility of the Secretaria de Medio Ambiente y Recursos Naturales through its established entities. We do not have further information regarding the effectiveness of this law for protecting the coastal California gnatcatcher and its habitat.

In Mexico, the development of state and municipal plans is designed to regulate and control land use and various production activities as well as provide environmental protections and preservation and sustainability of natural resources (Conservation Biology Institute 2004, p. 31). As an example, an *ordenamiento ecológico* (ecological regulation/zoning ordinance) is being developed for the City of Tijuana to identify *áreas verdes* (important natural resource areas), and the *ordenamiento* will be used to guide land development within Tijuana (Conservation Biology Institute 2004, p. 31). Other State and Federal environmental laws in Mexico include Ley General del Equilibrio Ecológico y la Protección al Ambiente and Ley de Protección al Ambiente para el Estado de Baja California, which require the preparation of an environmental impact study (*manifestación de impacto ambiental*) for any development project; if the project is determined to result in negative environmental impacts, the developer must undertake mitigation actions to minimize these impacts and/or restore natural conditions (Conservation Biology Institute 2004, p. 31).

EXISTING REGULATORY MECHANISMS SUMMARY

Outside of the Act, few Federal conservation management and conservation measures exist throughout the U.S. range of the coastal California gnatcatcher that provide protections to the subspecies and its habitat. State management and conservation measures are limited primarily to the planning and implementation of the NCCP Act, and there is uncertainty as to whether the regional plans would continue to provide the full conservation benefits anticipated should the subspecies be delisted under the Act. Limited protection is provided to the coastal California gnatcatcher through the inclusion of its designation as a Species of Special Concern within State (CEQA) planning processes.

Based on the best available data, the listing of the *atwoodi* subspecies of the California gnatcatcher by the Mexican Government provides a limited level of protection or conservation benefit to the *atwoodi* populations found in Baja California. Comprehensive reserve areas for coastal sage scrub and chaparral vegetation have not been established in northern Baja California. While existing Mexican regulatory mechanisms may provide some protection for the subspecies, we lack information on implementation of those mechanisms specifically related to protection of the coastal California gnatcatcher, protection of habitat, and abatement of threats.

Therefore, although regulatory mechanisms are in place and provide some protection to the coastal California gnatcatcher and its habitat throughout its range, absent the protections of the Act (for example, section 7, section 9, and section 10(a)(1)(B)), these mechanisms would provide substantially less protection from the stressors currently acting on the subspecies such as urban and agricultural development. Moreover, some of the threats faced by the species and its habitat, including wildland fire, vegetation type conversion, and fragmentation, are not readily susceptible to amelioration through regulatory mechanisms.

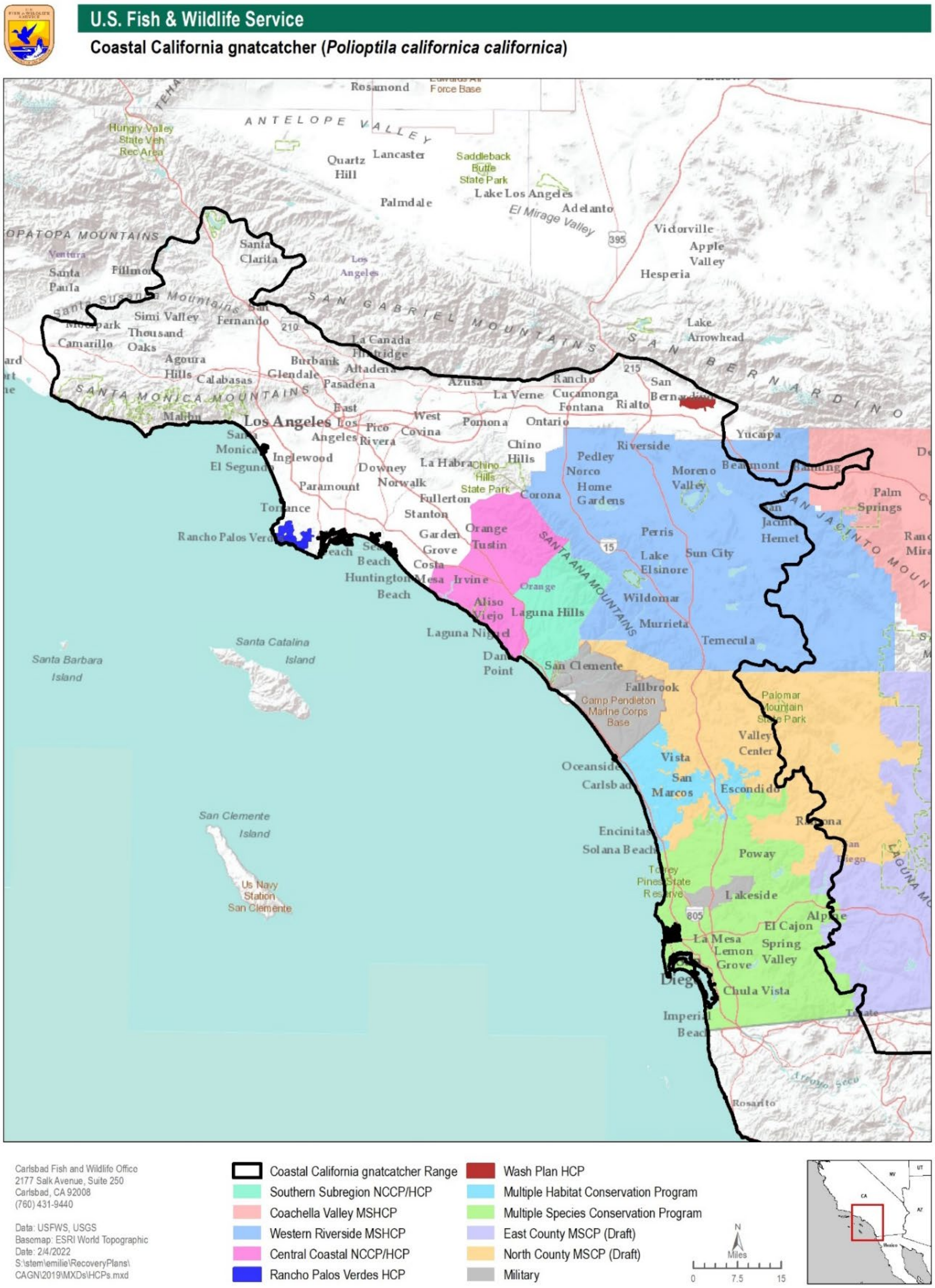

Figure 32. HCP/NCCPs and military installations within the U.S. range of the coastal California gnatcatcher.

APPENDIX B

Table B1. Coastal California gnatcatcher analysis unit and subarea size and ownership.

Geographic Analysis Unit	Subarea	Approximate Size of Unit (acres)	Proportion Federal Land	Proportion State Land	Proportion Local Land	Proportion Private Land
Northern Analysis Unit	Ventura	747,046	6%	7%	11%	75%
Northern Coastal Analysis Unit	Palos Verdes Peninsula/LA Metro	273,172	<1%	<1%	4%	95%
Northern Coastal Analysis Unit	North Orange County	110,770	5%	1%	4%	90%
Northern Coastal Analysis Unit	**Unit Total**	383,942	2%	1%	4%	93%
Middle Coastal Analysis Unit	Orange County Central Coastal	208,583	8%	2%	20%	70%
Middle Coastal Analysis Unit	Orange County South	131,776	29%	<1%	11%	60%
Middle Coastal Analysis Unit	Camp Pendleton/Fallbrook	134,284	100%	0%	0%	0%
Middle Coastal Analysis Unit	**Unit Total**	474,644	40%	1%	12%	47%
Middle Interior Analysis Unit	San Dimas/Chino Hills	387,618	3%	3%	7%	87%
Middle Interior Analysis Unit	Coyote Hills	28,334	1%	0%	5%	93%
Middle Interior Analysis Unit	San Bernardino	239,292	3%	0%	3%	94%
Middle Interior Analysis Unit	Western Riverside	938,550	14%	4%	4%	78%
Middle Interior Analysis Unit	**Unit Total**	1,593,794	9%	3%	5%	83%
Southern Analysis Unit	North County MSCP	306,844	14%	<1%	5%	81%
Southern Analysis Unit	San Diego MHCP	117,194	<1%	2%	10%	88%

Geographic Analysis Unit	Subarea	Approximate Size of Unit (acres)	Proportion Federal Land	Proportion State Land	Proportion Local Land	Proportion Private Land
Southern Analysis Unit	San Diego MSCP	528,131	10%	6%	15%	68%
Southern Analysis Unit	Miramar	22,892	100%	0%	0%	0%
Southern Analysis Unit	East County Areas	52,241	67%	1%	21%	10%
Southern Analysis Unit	**Unit Total**	1,027,302	15%	4%	12%	70%
Baja California Analysis Unit	Baja California	824,561	N/A	N/A	N/A	N/A
Total Range	**--**	**5,051,289**	--	--	--	--

Table B2. Analysis results of Habitat Conditions by Analysis Unit and Subareas (Habitat Suitability Model from Preston *et al*. 2020, entire).

Geographic Analysis Unit	Subarea	Approximate Size of Unit (acres)	Acres of Modeled habitat	Percent modeled habitat greater than or equal to 0.5 HSI (acres)	Acres of very high, high, and moderate habitat (HSI ≥ 0.25)	Percent suitable habitat within 30 km buffer (HIS ≥ 0.5)	Percent of Modeled Habitat Conserved (acres)
NAU	Ventura	**747,046**	**287,361**	**24% (69,690)**	**132,157**	**5%**	**11% (31,788)**
NCAU	Palos Verdes Peninsula/LA Metro	273,172	10,167	30% (3,085)	5,721		23% (2,368)
NCAU	North Orange County	110,770	4,924	7% (331)	1,468		74% (3,636)
NCAU	**Unit Total**	**383,942**	**15,091**	**23% (3,415)**	**7,189**	**3%**	**40% (6,003)**
MCAU	Orange County Central Coastal	208,583	76,068	56% (42,807)	58,232		71% (53,682)
MCAU	Orange County South	131,776	56,002	59% (33,076)	44,827		77% (43,271)
MCAU	Camp Pendleton/Fallbrook	134,284	114,637	70% (80,152)	98,389		100% (114,637)
MCAU	**Unit Total**	**724,301**	**246,707**	**63% (156,035)**	**201,448**	**22%**	**86% (211,590)**
MIAU	San Dimas/Chino Hills	387,618	85,312	31% (26,385)	49,151		18% (15,411)
MIAU	Coyote Hills	28,334	1,505	58% (872)	1,141		19% (279)
MIAU	San Bernardino	239,292	58,431	20% (11,653)	25,331		4% (2,351)
MIAU	Western Riverside	938,550	429,360	22% (96,328)	185,462		28% (119,432)
MIAU	**Unit Total**	**1,593,794**	**574,608**	**24% (135,238)**	**261,085**	**8%**	**24% (137,473)**
SAU	North County MSCP	306,844	145,788	27% (39,976)	68,921		11% (15,901)
SAU	San Diego MHCP	117,194	30,761	37% (11,255)	17,530		34% (10,386)
SAU	San Diego MSCP	528,131	197,827	42% (83,667)	120,185		53% (103,907)
SAU	Miramar	22,892	14,594	43% (6,334)	8,369		100% (14,594)

Geographic Analysis Unit	Subarea	Approximate Size of Unit (acres)	Acres of Modeled habitat	Percent modeled habitat greater than or equal to 0.5 HSI (acres)	Acres of very high, high, and moderate habitat (HSI ≥ 0.25)	Percent suitable habitat within 30 km buffer (HIS ≥ 0.5)	Percent of Modeled Habitat Conserved (acres)
SAU	East County Areas	52,241	14,812	12% (1,718)	4,910		64% (9,428)
SAU	**Unit Total**	**1,161,586**	**518,419**	**35% (142,950)**	**219,915**	**14%**	**52% (268,852)**
BCAU	Baja California	**824,561**	**10,597**[5]	**Unknown**	**Unknown**	**Unknown**	**Unknown**

[5] Habitat quantity estimate for the BCAU is not based on the habitat suitability model and instead uses data from INEGI (2018).