CLARK COUNTY MULTIPLE SPECIES HABITAT CONSERVATION PLAN AMENDMENT

VOLUME II

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Appendix A
Covered Species Accounts

Introduction

Clark County's Multiple Species Habitat Conservation Plan (MSHCP), adopted in 2000, established a framework for managing incidental take of covered species while allowing for continued land development within the county. The original MSHCP covered 79 Covered Species, 103 Evaluation Species, and 51 Watch List species (RECON 2000). Clark County is currently amending that permit with the U.S. Fish and Wildlife Service (USFWS) to reflect new scientific information, updated species distribution data, and changes in the regulatory landscape since the plan's adoption.

This appendix presents species accounts for the 28 proposed Covered Species under the MSHCP Amendment (Table 1). Each account synthesizes available information on the species' biology, range, habitat requirements, conservation status, population trends, threats, and management considerations within the context of Clark County and the MSHCP Plan Area. Each account also includes a summary of the species' habitat suitability model, which was developed to support the amendment. To provide context for the conservation analyses presented in the accounts, this appendix also includes an overview of lands managed for resource conservation within the Plan Area and a description of the habitat suitability modeling methods common to all covered species.

Species accounts are organized by taxonomic group and follow a standardized ten-section structure: (1) Species Overview, (2) Range, (3) Habitat Characteristics, (4) Habitat Suitability Model, (5) Species Status, (6) Population Trends, (7) Habitat Level Threats, (8) Threats to Species, (9) Conservation and Management, and (10) Clark County Survey Data. References cited within each account are listed at the end of that account.

Table 1. Proposed Covered Species

Common Name	Scientific Name	Page Number
Mammals (3)		
Desert pocket mouse	*Chaetodipus penicillatus*	A-13
Townsend's big-eared bat	*Corynorhinus townsendii*	A-22
Spotted bat	*Euderma maculatum*	A-32
Birds (10)		
Golden eagle	*Aquila chrysaetos*	A-43
Western burrowing owl	*Athene cunicularia hypugaea*	A-54
Yellow-billed cuckoo	*Coccyzus americanus*	A-66
Gilded flicker	*Colaptes chrysoides*	A-77
Southwestern willow flycatcher	*Empidonax traillii extimus*	A-87
Loggerhead shrike	*Lanius ludovicianus*	A-98
Yuma Ridgway's rail	*Rallus obsoletus yumanensis*	A-109
Bendire's thrasher	*Toxostoma bendirei*	A-119
LeConte's thrasher	*Toxostoma lecontei*	A-130
Bell's vireo	*Vireo bellii*	A-141
Reptiles (2)		
Desert tortoise	*Gopherus agassizii*	A-153
Gila monster	*Heloderma suspectum*	A-166
Amphibians (1)		
Arizona toad	*Anaxyrus microscaphus*	A-178
Invertebrates (2)		
Monarch butterfly	*Danaus plexippus*	A-189

Common Name	Scientific Name	Page Number
Mojave poppy bee	*Perdita meconis*	A-199
Plants (10)		
Sticky ringstem	*Anulocaulis leiosolenus* var. *leiosolenus*	A-208
Las Vegas bearpoppy	*Arctomecon californica*	A-222
Threecorner milkvetch	*Astragalus geyeri* var. *triquetrus*	A-235
Blue Diamond cholla	*Cylindropuntia multigeniculata*	A-247
Silverleaf sunray	*Enceliopsis argophylla*	A-258
Pahrump Valley buckwheat	*Eriogonum bifurcatum*	A-267
Las Vegas buckwheat	*Eriogonum corymbosum* var. *nilesii*	A-277
Sticky buckwheat	*Eriogonum viscidulum*	A-287
White-margined beardtongue	*Penstemon albomarginatus*	A-298
Eastern Joshua tree	*Yucca jaegeriana*	A-310

Lands Managed for Resource Conservation

A substantial portion of the MSHCP Plan Area is already managed for resource conservation under federal, state, and local authorities. These lands provide long-term protection for native plant communities, wildlife habitat, watersheds, cultural resources, and scenic values, and they form the foundation of the conservation context in which the covered species occur. Many of the covered species have a majority of their suitable habitat within Clark County falling on these managed lands, and the distribution of suitable habitat relative to these lands is a key consideration in evaluating the status of each species and in developing the Conservation Strategy presented in Chapter 6.

Federally managed conservation lands within the Plan Area include National Conservation Areas, National Monuments, National Recreation Areas, National Wildlife Refuges, Wilderness Areas, and Areas of Critical Environmental Concern (ACECs) designated by the U.S. Bureau of Land Management (BLM). These designations are administered by the BLM, the National Park Service (NPS), and USFWS, and together they account for the majority of conserved acreage in the county. Prominent examples include Red Rock Canyon National Conservation Area, Sloan Canyon National Conservation Area, Gold Butte National Monument, Lake Mead National Recreation Area, Desert National Wildlife Refuge, and Moapa Valley National Wildlife Refuge. ACECs are a particularly important tool for protecting sensitive resources on BLM lands, and several ACECs within the Plan Area were established specifically to conserve habitat for covered species such as the Mojave desert tortoise, Las Vegas bearpoppy, and rare plants of gypsum soils.

State and locally managed lands complement federal conservation areas and provide additional habitat protection within and adjacent to the urban landscape. These include Nevada State Parks such as Valley of Fire State Park, Nevada Department of Wildlife Wildlife Management Areas, and locally managed resource lands such as Clark County Wetlands Park. Although smaller in acreage than the federal conservation estate, these areas often protect habitats that are poorly represented on federal lands, including riparian corridors, wetlands, and lower-elevation valley habitats, and they provide important refugia for species whose ranges overlap substantially with developed or developing areas of the Las Vegas Valley.

For each covered species, the habitat suitability model described below was overlain with the footprint of lands managed for resource conservation (shown in Figure 1) to calculate the acreage and proportion of suitable habitat that already falls within protected status. These values are reported in the Habitat

Suitability Model and Conservation and Management sections of each species account and are summarized collectively in Chapter 3. This analysis provides a basis for evaluating the contribution of existing conservation lands to the persistence of each covered species and for identifying where additional conservation measures under the MSHCP Amendment are most needed.

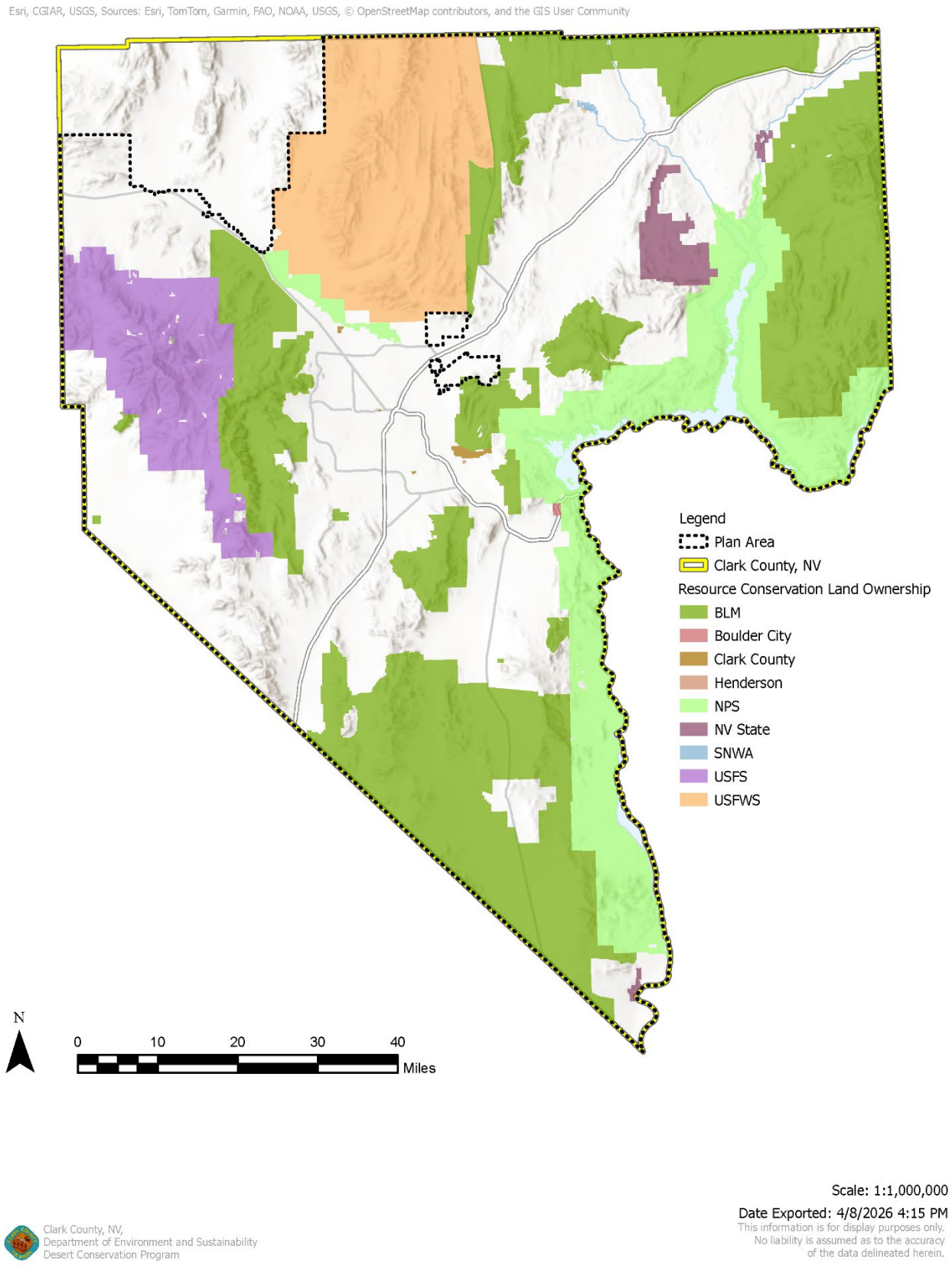

Figure 1. Lands Managed for Resource Conservation in Clark County, Nevada.

Species Habitat Suitability Modeling

Study Area

The study area used for habitat suitability modeling was defined as a 50-kilometer buffer surrounding the Clark County, Nevada boundary, consistent with earlier modeling efforts. All spatial analyses were conducted using a NAD83, UTM Zone 11N projection (EPSG 26911). Raster resolution for all input and output layers was set at 250-meter grid resolution; all environmental data and point occurrence data were cropped, masked, and resampled to this resolution and extent. Although the primary area of interest is Clark County, the broader buffered study area was used to capture the range of environmental conditions relevant to the covered species and to minimize edge effects in model predictions. For species-specific modeling that incorporated a categorical vegetation layer, the spatial extent was effectively limited to the Clark County boundary, where vegetation classification data were available (Nussear et al. 2024, Simandle and Nussear 2025).

Species Locality Data

Species occurrence records were compiled from multiple sources. The primary data came from earlier modeling efforts (Nussear and Simandle 2020; SWECO 2018) and were supplemented with updated records from iNaturalist and the Global Biodiversity Information Facility (GBIF), using research-grade or unobscured observations only. Additional locality data were provided by Clark County Desert Conservation Program staff. All occurrence records were reviewed for spatial accuracy and quality prior to use in modeling.

Because presence records are often spatially clustered, which can bias model predictions, occurrence data were first rasterized to the modeling resolution so that no grid cell contained more than one presence record. A geographically weighted resampling procedure was then applied, in which no more than three to four observations could be drawn from cells on a uniform grid at a spatial resolution four times coarser than the modeling resolution (approximately 1 km² for the 250-m modeling grid). This systematic grid-based approach reduces spatial bias across a variety of sampling conditions (Fourcade et al. 2014). Because verified absence records were unavailable for any of the covered species, all models were fit using pseudo-absences generated through a surface range envelope (bioclim algorithm; Hijmans et al. 2017). Background points equal in number to the observed occurrences were randomly drawn from areas falling outside the bioclim envelope, defined as areas with bioclim suitability values below 0.1. The use of pseudo-absences in this manner is well established for species distribution modeling when true absences are unavailable (Busby 1991; Wisz and Guisan 2009; Barbet-Massin et al. 2012).

Environmental Covariates

Environmental covariates used in habitat suitability modeling represent climate, topography, soils, vegetation, and land cover conditions across the study area. Climate variables were derived from PRISM data (800-m resolution, downscaled to 250 m) and include mean, maximum, and minimum temperatures, coefficient of variation statistics for temperature and precipitation, absolute extreme temperatures, winter precipitation, and vapor pressure deficit. Vegetation structure variables were obtained from U.S. Geological Survey (USGS) phenology datasets (NDVI amplitude, NDVI length of season, timing of NDVI maximum). Topographic variables were calculated from the USGS National Map

and include slope, aspect, surface roughness, and distance to cliffs. Soil variables were sourced from the Soil Grids 250-m project (Hengl et al. 2017) and include sand, silt, clay, coarse fragments, gypsum content, depth to bedrock, and a soil principal component index. Additional covariates include fractional cover of bare ground, shrubs, sagebrush, and herbaceous vegetation from the National Land Cover Database; distance to permanent water; a silica index derived from ASTER data; and percent washes calculated from the USGS National Map. A full list of environmental covariates and their sources is provided in Table 2.

For species-specific models that incorporated a categorical vegetation layer, a plant association classification dataset (Vegetation_USNVC_Divisions) provided by the Desert Conservation Program was included. This layer contains 16 vegetation association groups and was restricted in spatial extent to the Clark County boundary, with coverage of the Lake Mead area included in final model versions. Because vegetation is a categorical variable, it required modified modeling procedures and affected algorithm selection, as described in the statistical methods below.

Table 2. Environmental covariates used in habitat suitability modeling, with variable codes and data sources.

Variable Name	Variable Code	Source
Climate		
Mean temperature	MeanTemp.r	PRISM (https://prism.oregonstate.edu/); mean of monthly temperatures across the 30-year period
Absolute maximum temperature	tmax.r	PRISM; absolute maximum temperature in dataset (degrees C)
Absolute minimum temperature	tmin.r	PRISM; absolute minimum temperature in dataset (degrees C)
CV maximum temperature	CVMaxTemp.r	PRISM; coefficient of variation of monthly maximum temperature across the 30-year period (degrees C)
CV minimum temperature	CVMinTemp.r	PRISM; coefficient of variation of monthly minimum temperature across the 30-year period (degrees C)
Winter precipitation	wp.r	PRISM; mean cumulative winter precipitation (October to March) across the 30-year period (mm H_2O)
CV winter precipitation	wpcv.r	PRISM; coefficient of variation of annual winter precipitation across the 30-year period (mm H_2O)
Vapor pressure deficit maximum	vpdMax.r	PRISM; daily maximum vapor pressure deficit (difference between saturated and actual vapor pressure; hectopascals)
Vegetation Phenology		
NDVI amplitude	NDVIamplitude.r	USGS Phenology Network; mean amplitude of NDVI season (unitless)
NDVI length of season	NDVIDuration.r	USGS Phenology Network; mean length of NDVI season (Julian days)
NDVI timing of maximum	NDVIMaxT.r	USGS Phenology Network; mean timing of maximum NDVI (Julian date)
Topography		
Slope	slope.r	USGS National Map; calculated from digital elevation model (degrees)
Aspect	aspect.r	USGS National Map; calculated from digital elevation model (degrees)
Surface roughness	rough.r	Inman et al. 2014 (unitless)

Variable Name	Variable Code	Source
Distance to cliffs	D2cliff.r	Inman et al. 2014; straight-line distance to cliff features (m)
Percent washes	n/a	USGS National Map; percent of cell covered by wash features (%)
Soils		
Soil principal component 1	soil1.r	Soil Grids 250m (Hengl et al. 2017); first principal component of percent sand, silt, and clay (unitless)
Coarse fragments	coarse.r	Soil Grids 250m (Hengl et al. 2017); volumetric coarse fragment content (cm^2/dm^3)
Absolute depth to bedrock	bedrock.r	Soil Grids 250m (Hengl et al. 2017); absolute depth to bedrock (m)
Gypsum content	gypsum.r	Soil Grids 250m (Hengl et al. 2017); gypsum content (%)
Land Cover		
Fractional cover of bare ground	bare.r	National Land Cover Database (NLCD); fractional percent bare ground cover (%)
Fractional cover of shrub	shrub.r	National Land Cover Database (NLCD); fractional percent shrub cover (%)
Fractional cover of sagebrush	sage.r	National Land Cover Database (NLCD); fractional percent sagebrush cover (%)
Fractional cover of herbaceous	herb.r	National Land Cover Database (NLCD); fractional percent herbaceous cover (%)
Other		
Distance to water	d2h2o.r	EPA WATERS geospatial data; straight-line distance to permanent water features (m)
Silica index	silicaIndex.r	NASA ASTER data; silica index derived from multispectral imagery (unitless)
Categorical vegetation layer	veg (categorical)	Clark County Desert Conservation Program; USNVC plant association/alliance group polygons; 16 vegetation classification groups; used in species-specific vegetation-inclusive models only

Statistical Modeling Methods

Habitat suitability models were developed using an ensemble modeling approach that incorporated four algorithms commonly applied in species distribution modeling: generalized additive models (GAM; Wood 2006), random forests (RF; Liaw and Wiener 2002), MaxEnt (version 3.4.1; Phillips et al. 2006) implemented via the Maxnet algorithm in R (maxnet v 0.1.4; Phillips 2021), and generalized boosted regression models (GBM; Greenwell et al. 2019). All models were executed using custom species distribution modeling code developed for Clark County. The use of multi-algorithm ensembles reduces reliance on the assumptions and limitations of any single method while enabling detection of a broader range of environmental response patterns (Araujo and New 2006). GAM, RF, MaxEnt, and GBM have consistently been identified as top-performing algorithms for habitat distribution modeling in empirical evaluations (Franklin 2010). All modeling was conducted in R version 4.3 (R Core Team 2023).

To fit and evaluate all models, 20-fold cross-validation was used. In each iteration, 80 percent of spatially thinned presence points were used for model training and 20 percent were withheld for evaluation. Background points were independently drawn for each cross-validation iteration. To select candidate

models for ensemble generation, models from each algorithm were retained if their True Skill Statistic (TSS) exceeded the mean TSS across all models of that algorithm. Ensemble predictions for each species were generated by computing a weighted average of candidate models within each algorithm type, with weights proportional to TSS scores. The final ensemble habitat suitability layer represents the weighted average prediction across all algorithm-level ensembles. Interaction terms were not included, to maintain model interpretability and generalization across the study area.

For models that included the categorical vegetation layer, the GAM algorithm was excluded because of convergence issues, and MaxEnt models were excluded because all candidate runs converged on uniformly present or absent outputs. Accordingly, vegetation-inclusive models rely on the RF and GBM algorithms only. For these models, pseudo-absence data were augmented with up to five random points stratified within each of the 16 vegetation strata, to ensure all categories were represented in both the presence and absence datasets (Simandle and Nussear 2025). The modeling report notes a technical limitation associated with constraining models to politically or administratively defined boundaries: such boundaries often fail to reflect the biological or environmental processes that structure species distributions, can reduce sample sizes, and may inflate spatial autocorrelation among samples, limiting the ecological relevance and generality of resulting models (Simandle and Nussear 2025).

Model Interpretation

Model performance was assessed using three threshold-independent metrics calculated from evaluation data across all cross-validation iterations and averaged across runs: (1) the area under the receiver operating characteristic curve (AUC; Fielding and Bell 1997), which measures rank discrimination between presences and background points on a scale from 0.5 (random) to 1.0 (perfect), though AUC can be sensitive to pseudo-absence sampling and spatial sorting (Lobo et al. 2008; Phillips et al. 2009; Roberts et al. 2017); (2) the True Skill Statistic (TSS; Allouche et al. 2006), which accounts for both omission and commission errors and ranges from -1 to 1, with values above 0.7 considered high performance for species distribution modeling; and (3) the Continuous Boyce Index (CBI; Boyce et al. 2002; Hirzel et al. 2006), which measures how much model predictions deviate from a random distribution of evaluation presences across the suitability gradient, ranging from -1 to 1, where values near 1 indicate that presences are concentrated at high suitability scores.

To support biological interpretation of model outputs, the relative importance of environmental predictors was calculated across candidate models for each algorithm. Partial response curves were derived for the top four environmental predictors within each algorithm, illustrating the shape of the predicted relationship between habitat suitability and each covariate while holding all other variables at their mean value (Elith et al. 2005). These curves were averaged across candidate models to produce ensemble partial response curves. Histograms of covariate values drawn from combined presence and pseudo-absence locations were overlaid on response curve plots to show the distribution of observed values across the study region. Layers representing the standard error of each ensemble prediction were also generated as the standard deviation of predictions across all candidate models, divided by the square root of the number of candidate models; standard errors were generally low (below 0.05) across the study area, indicating strong agreement among ensemble members (Simandle and Nussear 2025). Continuous Predicted/Expected (P/E) ratio curves based on the CBI were calculated using the ecospat package (v 3.0) in R, to evaluate each model's ability to resolve biologically meaningful suitability categories (Hirzel et al. 2006).

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Species Accounts
Mammals

Desert Pocket Mouse (*Chaetodipus penicillatus*)

Photo Source: Project 2017-BEC-1782A

Photo Source: Project 2021-BEC-2095D

Species Overview

The desert pocket mouse (*Chaetodipus penicillatus*) is a medium-sized heteromyid rodent characterized by fur-lined cheek pouches, a long tufted tail, and coarse grayish-brown to yellowish-gray pelage often sprinkled with black (NDOW 2022). Adults measure approximately 22 centimeters in total length and weigh around 23 grams (NatureServe 2026). The species belongs to the coarse-haired pocket mouse subgroup and is one of three pocket mouse species in southern Nevada; the little pocket mouse (*Perognathus longimembris*) is smaller, and the long-tailed pocket mouse (*Chaetodipus formosus*) is comparable in size (SWECO 2018).

The species is strictly nocturnal and non-migratory. Activity peaks during the breeding season (April through August) and is reduced during the hottest and driest months, when individuals may become torpid for several days at a time (Mantooth and Best 2005; NDOW 2022). Home ranges are typically small, generally less than 0.5 acre for both adults and juveniles (NatureServe 2026). The species builds spherical nests of dry grass dug into the soil, typically at a depth of about 18 centimeters, and stores food in its underground burrow system (NDOW 2022). Annual population turnover is nearly complete, with few individuals surviving beyond one year in the wild (NDOW 2022).

The desert pocket mouse is granivorous, feeding primarily on seeds of mesquite, creosote bush, and broomweed (Mantooth and Best 2005). Following a gestation period of 26 or more days, females produce one or more litters of 3 to 4 pups from early spring to late summer. Females can reach sexual maturity early and may become pregnant while still in juvenile pelage (NDOW 2022).

Range

The desert pocket mouse occurs across the Mojave and Sonoran Deserts in the southwestern United States and into northwestern Mexico. In the United States, the species' range extends from southeastern California east to southwestern New Mexico, and north into the southern portions of Nevada and Utah. The range also extends into Mexico, encompassing the northern two-thirds of Sonora and northeastern Baja California Norte (Mantooth and Best 2005; Jezkova et al. 2009). NatureServe estimates the global

range extent at approximately 457,584 km² (NatureServe 2026). Globally, the species is ranked G5 (Secure) by NatureServe and Least Concern by the IUCN.

Six subspecies of desert pocket mouse are recognized (Jezkova et al. 2009). Earlier taxonomic work recognized *Chaetodipus penicillatus sobrinus* as a Mojave Desert subspecies (Lee et al. 1996). Subsequent genetic analysis by Wood et al. (2013) identified a divergence between Mojave and Sonoran lineages along the Colorado River corridor, effectively restricting the recognized range of *C. p. sobrinus* to an area almost entirely within Clark County, Nevada. In Nevada, the species is ranked S1S2 (Critically Imperiled to Imperiled), representing the northern limit of its range; the state of Nevada represents the range limit for this taxon (NDOW 2022; NatureServe 2026). State ranks in other portions of the range include S5 (Secure) in Arizona, S3 (Vulnerable) in New Mexico, and S1 (Critically Imperiled) in Utah, where the species is at the periphery of its range (NatureServe 2026).

In Clark County, *C. p. sobrinus* occurs from the northeast corner near the Arizona and Utah borders and southern Lincoln County, south to the southern tip of Clark County near the border of Arizona and California (NDOW 2022). Habitat modeling for the county predicts high-suitability habitat concentrated within lower-elevation drainages, including the Moapa Valley, the Muddy and Virgin River corridors, the Las Vegas Wash, and shorelines along Lake Mead and the Colorado River (SWECO 2018). The elevational range for the species in the county is 36 to 1,585 m (SWECO 2018).

Habitat Characteristics

Desert pocket mice occupy open desert environments with sparse vegetation, preferring soft alluvial, sandy, or silty soils. In Nevada, the species is associated with the Mojave Warm Desert, Mojave Mid-Elevation Mixed Desert Scrub, and Riparian and Wetland habitat types (NDOW 2022). Within these broad types, the species shows particular affinity for creosote bush (*Larrea tridentata*) and saltbush (*Atriplex* spp.) communities, mesquite bosques, and desert washes (Mantooth and Best 2005; NDOW 2022). The species also utilizes yucca, mesquite/catclaw, and short grass vegetation associations (NDOW 2022).

Desert pocket mice strongly prefer rock-free bottomland soils along rivers, streams, desert washes, and valleys over rocky terrain (NatureServe 2026; NDOW 2022). Densities are generally positively associated with shrub cover and diversity (SWECO 2018). This species is not found in areas with sparse vegetation or gravelly to rocky substrates, which are instead occupied by the similar long-tailed pocket mouse (*Chaetodipus formosus*) (BEC 2021).

In Clark County, the species is most consistently associated with riparian and wash habitats featuring loose, sandy or silty soils and moderate to dense shrub cover with some open interspace. Survey results have documented the species in sandy or silty lowlands, floodplains, and shorelines adjacent to permanent or ephemeral water sources with shrubs such as quailbush, tamarisk, arrowweed, and mesquite (BEC 2021). Habitat within the lower Colorado drainage system is considered highly fragmented, reducing resilience to disturbance and increasing the risk of local extirpation. Remnant populations may exist within urban areas, but limited dispersal corridors prevent connectivity with surrounding populations (Micone 2002).

Habitat Suitability Model

Simandle and Nussear (2025) developed an updated habitat suitability model for the desert pocket mouse as part of a broader covered species modeling effort for the MSHCP Amendment. The model was

built using an ensemble approach incorporating multiple statistical algorithms and evaluated using area under the receiver operating characteristic curve (AUC), Boyce Index (BI), and TSS performance metrics. Model variable importance indicated that average minimum temperature, winter precipitation variability (coefficient of variation), and soil properties (silt content) were among the most influential predictors of habitat suitability for this species (Simandle and Nussear 2025).

Vegetation associations at locality points were predominantly North American Warm Desert Scrub and Grassland, with some contribution from Land Use and Development and Western North American Interior Flooded Forest vegetation types (Simandle and Nussear 2025).

High-suitability habitat within Clark County is predicted to occur primarily within lower-elevation drainages in the eastern portion of the county, including the Moapa Valley, the Muddy and Virgin River corridors, the Las Vegas Wash, and shorelines along Lake Mead and the Colorado River. Ecosystems with the highest concentrations of high-suitability modeled habitat include Mojave Desert Scrub, Desert Riparian, Salt Desert Scrub, and Mesquite/Acacia (SWECO 2018). The habitat suitability model for this species is presented in Figure 2.

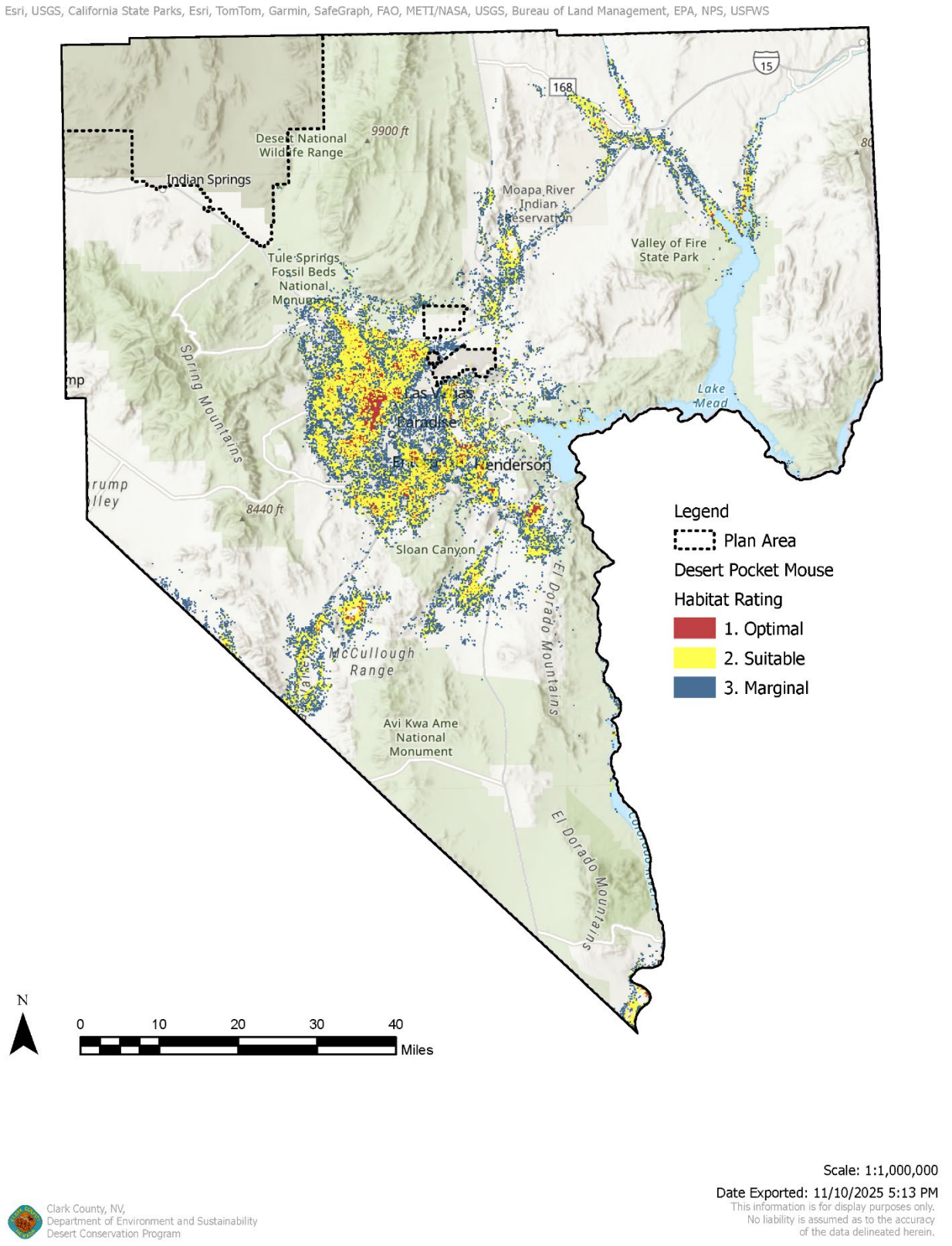

Figure 2. Habitat Suitability Model for Desert Pocket Mouse (*Chaetodipus penicillatus*) in Clark County, Nevada (Simandle and Nussear 2025).

Species Status

Agency/Organization	Status
MSHCP (2000)	Evaluation
U.S. Fish and Wildlife Service Endangered Species Act	None
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	None
State of Arizona	Species of Greatest Conservation Need
State of California	None
State of Utah	None
NV Division of Natural Heritage	At Risk
NV State Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Moderately Vulnerable
NatureServe Global and NV State Rank	G5 S1S2
IUCN Red List	Least Concern
CITES	None

The desert pocket mouse holds a global conservation rank of G5 (Secure) from NatureServe, reflecting that rangewide it is widespread in the Sonoran Desert of the southwestern United States and northwestern Mexico with no major rangewide threats currently identified (NatureServe 2026). The species is not listed under the U.S. Endangered Species Act and carries no CITES designation. The IUCN Red List rates the species as Least Concern, based on a stable population, wide distribution, and presumed large global population (SWECO 2018).

In Nevada, the species is assigned a state rank of S1S2 (Critically Imperiled to Imperiled) by NatureServe and the Nevada Natural Heritage Program, reflecting the restricted and fragmented distribution of the species at the northern limit of its range (NatureServe 2026; NDOW 2022). The Nevada State Wildlife Action Plan identifies the desert pocket mouse as a Species of Greatest Conservation Need, and the Nevada Climate Change Vulnerability Index rates it as Moderately Vulnerable. Although no formal state or federal listing currently applies, rapid growth, natural habitat loss in Clark County, and local scientific interest in the subspecies may result in a listing petition over the MSHCP permit term (SWECO 2018).

Population Trends

The Nevada State Wildlife Action Plan (NDOW 2022) characterizes the population trend for the desert pocket mouse as unknown, noting that populations are disjunct and suitable habitat is typically fragmented, potentially contributing to declining populations (NDOW 2022). At the global scale,

NatureServe and the IUCN list population trends as unknown or stable, with no major rangewide threats identified (NatureServe 2026; SWECO 2018).

A landscape genomics study conducted by BEC (2023) provided the most detailed available assessment of population status for the Clark County subspecies *C. p. sobrinus*. That study identified three genetically distinct, geographically isolated populations within Clark County: the Muddy/Virgin Rivers population, the Las Vegas Wetlands population, and the Laughlin population. Approximately 37 percent of total genetic variation is distributed among the three groups, indicating significant long-term isolation likely spanning thousands of years, consistent with the desiccation of pluvial lake systems that previously connected them (BEC 2023).

Historical effective population size (Ne) estimates show dramatic declines across all three Clark County populations. The Muddy/Virgin Rivers population, historically the largest, had Ne values estimated as high as approximately 4,000 in the distant past, declining to roughly 200 in recent generations. The Las Vegas Wetlands and Laughlin populations declined to values below 100. These figures are at or below thresholds generally considered adequate for long-term viability (Ne of 50 to 100 or more, per current literature) (BEC 2023). Neutrality tests indicate the Muddy/Virgin Rivers population has undergone recent demographic expansion following a bottleneck, which may reflect some recovery, while the other two populations show patterns consistent with stasis or continued decline (BEC 2023).

All three Clark County populations have low genetic diversity due to prolonged isolation, which increases susceptibility to disease and reduces adaptive potential in the face of climate change (BEC 2023). The Laughlin population additionally represents a probable zone of introgression with *C. p. penicillatus* from populations in Arizona to the south (BEC 2023).

Habitat Level Threats

Threats to desert pocket mouse habitats in Clark County include conversion of habitat through urban and suburban development, invasive species establishment, off-highway vehicle use, and recreational activities (NDOW 2022; SWECO 2018). Urban development in southern Nevada represents a high-level ongoing threat, resulting in habitat fragmentation and loss in the core of the subspecies' range (NDOW 2022). Proposed and operational solar power facilities also pose a risk to local populations through direct disturbance and habitat alteration (NDOW 2022).

Off-highway vehicle use in suitable habitat is detrimental through soil compaction, loss of native vegetation, and direct impacts on individuals. Off-highway vehicle activity can cause structural damage to shrubs and soil disturbance that leads to accelerated erosion, reducing habitat suitability (NDOW 2022; SWECO 2018). Roads and railroads represent a low-level but permanent disturbance on the landscape, with reduced dispersal potential and direct mortality risk (NDOW 2022).

Invasive plant species pose a significant long-term threat to habitat quality by displacing native shrubs, forming dense monocultures that lack the shrub interspace needed for foraging, increasing erosion, and destabilizing soil substrates important for burrowing (SWECO 2018; BEC 2023). Habitat within the lower Colorado drainage system is already considered highly fragmented, limiting resilience to further disturbance. Drought and increasing temperatures resulting from climate change are expected to degrade vegetation and reduce foraging opportunities (NDOW 2022).

Threats to Species

In addition to habitat-level threats, the desert pocket mouse faces direct species-level risks. Fire associated with invasive annual grasses can rapidly destroy food and cover vegetation critical to the species. Off-highway vehicle use can cause direct mortality and potentially reduce individual fitness through noise-induced hearing loss, increasing vulnerability to predation (SWECO 2018).

Increased anthropogenic water extraction threatens the groundwater and soil moisture that sustains riparian vegetation essential to the species in Clark County (BEC 2023). Continued aridification of the Mojave Desert under projected climate change scenarios is expected to further degrade habitat quality and extent (BEC 2023). Because all three Clark County populations have low genetic diversity due to prolonged isolation, individuals may be at heightened risk from novel pathogens and have a reduced capacity to adapt to environmental change (BEC 2023).

The two desert pocket mouse species in Clark County, desert pocket mouse and the long-tailed pocket mouse (*Chaetodipus formosus*), are morphologically similar and can only be reliably differentiated by cranial measurements, which has historically complicated the accuracy of occurrence records and may result in underestimates of population density and distribution (BEC 2021).

Conservation and Management

The desert pocket mouse is identified as a Species of Greatest Conservation Need in the 2022 Nevada State Wildlife Action Plan, which recommends conducting targeted survey efforts in suitable habitat, monitoring population status and trend across its range, and assessing impacts from landscape development projects (NDOW 2022). Conservation strategies also include maintaining the species' habitat at its current distribution in stable or increasing condition, expanding protected status for mesquite bosques and desert wash habitats, and sustaining stable or increasing populations of wildlife in key habitats (NDOW 2022).

The species is covered under the Lower Colorado River Multi-Species Conservation Program, which aims to conserve habitat for threatened and endangered species, reduce additional species listings, and provide a basis for incidental take authorizations (SWECO 2018).

A landscape genomics study (BEC 2023) recommended that conservation planning focus on maintaining and enhancing habitat connectivity within each of the three Clark County populations' ranges, rather than between populations, given the significant distances separating the groups. The study also recommended prioritizing the genetic preservation of each population as a distinct conservation unit, given the significant structuring among groups. Additional management recommendations from BEC (2023) include: conducting population dynamics studies and establishing long-term monitoring programs for each of the three populations; surveying riparian habitats along the intervening Colorado River corridor for additional occupied areas, with particular attention to the Overton Wildlife Management Area and spring-fed sites near Stewarts Point; and evaluating the physiological tolerances and adaptive capacity of each population under projected climate change and anthropogenic water use scenarios. The study further recommended reassessing the subspecies taxonomy of *C. penicillatus* through formal analysis, noting that regardless of taxonomic outcome, Clark County's three populations warrant conservation and management as distinct units (BEC 2023).

Based on the habitat suitability model developed by Simandle and Nussear (2025), the table below summarizes the extent of suitable habitat for the desert pocket mouse within the MSHCP Amendment Plan Area.

Desert pocket mouse (*Chaetodipus penicillatus sobrinus*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	274,564	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	29,659	10.8%
Suitable Habitat in Lands Managed for Resource Conservation	60,462	22.0%
Suitable Habitat in the existing MSHCP Reserve System	2,681	1.0%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	1,162	0.4%

*Simandle and Nussear 2025

Clark County Survey Data

The earliest systematic surveys for desert pocket mouse in Clark County documented the species in association with sandy washes, floodplains, and riparian shrub communities along the Muddy and Virgin Rivers and Las Vegas Wash corridors. Earlier habitat modeling efforts, including the EPA's Southwest Regional Gap Analysis (2008) and a USGS Mojave Desert modeling study by Inman et al. (2014), identified the watersheds of the Muddy and Virgin Rivers and the Las Vegas Wash as core habitat areas, with potential additional habitat in the Eldorado and Ivanpah Valleys (SWECO 2018). The USGS Inman et al. (2014) model identified approximately 116 km² of high-suitability modeled habitat within Clark County using occurrence data from 99 observations.

BEC Environmental conducted a small mammal inventory in 2020 within the Riparian Reserve System Units along the Muddy and Virgin Rivers (BEC 2020). That effort resulted in 27 captures of desert pocket mouse across five of six surveyed riparian reserve units: 4 at Muddy River, 1 at Mormon Mesa, 3 at Bunkerville West, 8 at Bunkerville East, and 11 at Riverside. No individuals were captured at the Mesquite West unit. The species was captured at all sites with appropriate sandy floodplain habitats with dense riparian shrub cover (BEC 2021).

BEC Environmental conducted targeted protocol surveys for desert pocket mouse across Clark County in 2021 (BEC 2021). Results confirmed that the species is associated with sandy or silty lowlands, floodplains, and shorelines near permanent or ephemeral water with shrubs such as quailbush, tamarisk, arrowweed, and mesquite. The surveys also documented the morphological similarity between the desert pocket mouse and the long-tailed pocket mouse, noting that reliable differentiation requires cranial measurements. Survey efforts established detection at three geographically distinct areas corresponding to the Muddy/Virgin Rivers, Las Vegas Wetlands, and Laughlin areas of Clark County. The 2021 project encompassed 4,160 trap-nights across 35 trapping sites distributed among 11 target areas, with 729 individual small mammals of 13 species captured. A total of 87 individual desert pocket mice were captured at 13 of the 35 trapping sites within 4 of the 11 target areas, all within the Colorado River watershed. The species was not detected at any site outside the watershed, including areas within the Jean Lake, Jean/Ivanpah, Sloan, South of Henderson, or Apex/North Las Vegas target areas despite the presence of what the habitat suitability model characterized as suitable habitat (BEC 2021).

In 2023, BEC Environmental completed a landscape genomics study for the three Clark County populations (BEC 2023). Genetic analysis confirmed the presence of three genetically distinct, geographically isolated populations of *C. p. sobrinus* within Clark County, with approximately 37 percent of total genetic variation distributed among the three groups. Historical effective population size

estimates indicated that all three populations have undergone significant decline from historical highs. The Muddy/Virgin Rivers population showed evidence of recent demographic expansion following a bottleneck, while the Las Vegas Wetlands and Laughlin populations showed patterns consistent with continued decline or stasis. The Laughlin population was identified as a probable introgression zone between *C. p. sobrinus* and *C. p. penicillatus* (BEC 2023).

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Townsend's Big-eared Bat (*Corynorhinus townsendii*)

Photo Credit: Mike Swink, SWCA

Photo Credit: Mike Swink, SWCA

Species Overview

Townsend's big-eared bat, also known as the western big-eared bat, is a medium-sized bat (80 to 100 mm in length, 7 to 12 g) with very large ears (approximately 38 mm) and a wingspan of 24 to 28 cm. The ears are flexible and may curl around the head when roosting. Small bilateral horseshoe-shaped lumps (enlarged sebaceous perirhinal glands) occur on either side of the snout, lending the nickname "lump-nosed bat" (NBWG 2024). Fur is pale gray-brown above and buff-colored on the underside. Townsend's big-eared bat can be distinguished from all other vespertilionid bats by the presence of these prominent bilateral nose lumps (NDOW 2022).

Townsend's big-eared bats are slow-flying clutter specialists with low wing-loading that facilitates prey pursuit through vegetation. Echolocation calls are quiet and low intensity, emitted through both the nose and mouth, which reduces detection probability with acoustic recording devices (NBWG 2024). They are insectivorous, feeding primarily on moths; over 90 percent of their diet is composed of lepidopterans (NDOW 2022). They forage late in the day, preferring edge habitats between forested and open areas, and may travel over 150 km between roosting and foraging areas in a single night (NDOW 2022; NatureServe 2026).

Mating generally occurs in the fall and winter, with ovulation and fertilization delayed until late winter or early spring. Gestation lasts 2 to 3.5 months, and females produce a single pup in late spring or early summer. Young are capable of flight within three weeks and are weaned by six weeks (Kunz and Martin 1982). Females form maternity colonies in the warm portions of caves or mines, while males roost solitarily during this period. Maximum longevity exceeds 21 years (Perkins 1994). Seasonal movement patterns are not well understood, though there is some evidence of local migration, perhaps along altitudinal gradients (NDOW 2022).

Townsend's big-eared bat migrates only short distances (less than 30 km) between seasons (Kunz and Martin 1982; Dobkin et al. 1995). They typically roost in large open caves, abandoned mines, tunnels, and buildings, inhabiting a wide variety of habitats from pine woodlands to desert scrub ecosystems, though they are not common in extreme desert habitats (Kunz and Martin 1982; Pierson and Rainey 1998; Mazurek 2004). This species is highly sensitive to disturbance, particularly at maternity sites and during winter hibernation.

Range

Townsend's big-eared bat has a broad range in western North America, from southern British Columbia, Canada, south through the western United States to southern Mexico, and east to Texas and the U.S. Midwest (Kunz and Martin 1982; NatureServe 2026). The species has significant populations in all Rocky Mountain states, including Arizona, Colorado, Utah, Wyoming, Idaho, and Montana, as well as Texas, South Dakota, Kansas, northwestern Arkansas, and southern Missouri, and westward through California, Oregon, and Washington. Elevational range extends from near sea level to at least 3,300 m in some areas (NDOW 2022).

Four subspecies are recognized. Two eastern subspecies, the Ozark big-eared bat (*Corynorhinus townsendii ingens*) and the Virginia big-eared bat (*C. t. virginianus*), are federally listed as Endangered under the Endangered Species Act. The two western subspecies (*C. t. townsendii* and *C. t. pallescens*) are more broadly distributed and are not federally listed (NatureServe 2026).

Townsend's big-eared bats are found throughout Nevada, from low desert to high mountain habitats (NDOW 2022). The habitats in Nevada where this species occurs include juniper-mountain mahogany, sagebrush, desert scrub, agricultural areas, and occasionally urban areas (Rahn 2000). Their distribution within Nevada is strongly correlated with the availability of abandoned mines and caves (NDOW 2022).

In Clark County, Townsend's big-eared bats have been observed near the eastern end of Lake Mead and in the Newberry Mountains (RECON 2000), physically captured and acoustically recorded in the upper Muddy River (Williams et al. 2006), and detected at multiple locations throughout the county during passive acoustic surveys conducted in 2022 and 2024 (SWCA 2025). The greatest concentrations of verified occurrence localities in the Mojave Desert region are in the Spring Mountains of western Clark County (SWECO 2018).

Habitat Characteristics

Townsend's big-eared bat occupies a broad range of habitats across its distribution, including coniferous and deciduous forests, woodlands, shrublands, grasslands, desert scrub, and riparian areas, though it is generally uncommon in prairies and extreme desert settings (NatureServe 2026). In Nevada, this species is found at elevations from 210 to 3,500 m in pinyon-juniper-mahogany, white fir, blackbrush, sagebrush, salt desert scrub, agricultural, and occasionally urban habitats (NDOW 2022). Foraging associations include edge habitats along streams and a variety of wooded habitats.

Roosting habitat is a primary limiting factor for this species; populations tend to occur in areas dominated by exposed, cavity-forming rock and historic mining districts (Bradley et al. 2006; NDOW 2022). Roosting habitats are typically mines, caves, and other cave-like structures. During hibernation, Townsend's big-eared bats prefer habitats with relatively cold but above-freezing temperatures in quiet, undisturbed locations. They often roost in clusters during hibernation in very cold sites, and will hang in the open to maximize exposure to cold air rather than in crevices like other hibernating bat species (NDOW 2022).

Females gather in small nursery colonies in the warm portions of caves or mines; individuals generally return to the same maternity roost in successive years (NDOW 2022). Males tend to roost singly, spread across the landscape. Night roosts include caves, buildings, and tree cavities. In Clark County, predicted higher suitability habitat occurs in upland areas near blackbrush, pinyon-juniper, mixed conifer, and alpine ecosystems; occurrence in lowlands is thought to be primarily for foraging (SWECO 2018).

Habitat Suitability Model

Habitat suitability for Townsend's big-eared bat in the vicinity of Clark County was modeled by Simandle and Nussear (2025) using an ensemble modeling approach. The ensemble model demonstrated excellent predictive performance, with testing AUC = 0.9914 and TSS = 0.9314, indicating strong discriminatory ability across thresholds and high accuracy at the selected cutoff. The CBI further confirmed robust model performance, showing that once predicted suitability exceeds approximately 80 percent, observed presences occur up to five times more often than expected at random.

Several environmental variables were identified as influential drivers of habitat suitability. The coefficient of variation in winter precipitation (wpcv) was the strongest predictor across model algorithms; suitability is low when wpcv is low, increases nearly linearly, and remains high once wpcv exceeds 0.7. Terrain slope was influential in multiple models, with peak suitability around 10 degrees and lower suitability at steeper slopes. The first principal component of soil sand, silt, and clay composition was important in two models, with higher suitability associated with lower soil1 values. The coefficient of variation of minimum temperature was also identified as influential, with highest suitability at lower values.

Areas of high habitat suitability for Townsend's big-eared bat are broadly distributed across Clark County, generally corresponding to higher elevation terrain, while suitability is low in valleys and lowlands. The highest concentrations of suitable habitat are predicted in the Spring Mountains and adjacent areas of the Birdsprings Range, with highly suitable habitat also identified along the Las Vegas Range, Sheep Range, and Muddy Mountains. Within the buffered analysis area, highly suitable habitat extends into the Ivanpah Mountains, Mesquite Mountains, and New York Mountains in California, and the Black Mountains in Arizona. Moderately suitable habitat is widely distributed throughout the region (Simandle and Nussear 2025). The habitat suitability model for Townsend's big-eared bat within the vicinity of Clark County is presented in Figure 3.

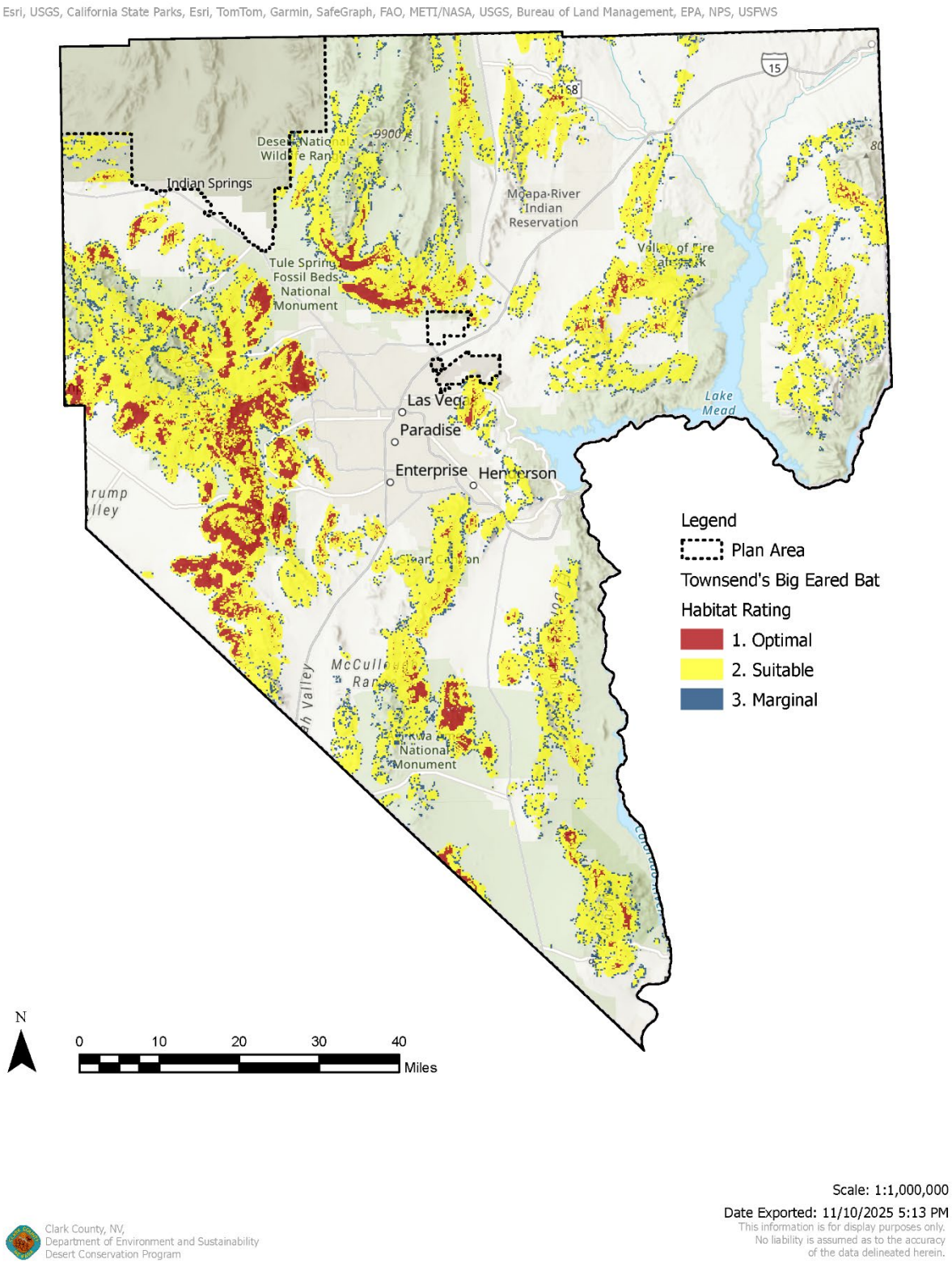

Figure 3. Habitat suitability model for Townsend's big-eared bat (*Corynorhinus townsendii*) in Clark County, Nevada (Simandle and Nussear 2025).

Species Status

The regulatory and conservation status of Townsend's big-eared bat across applicable agencies and organizations is summarized in the table below.

Agency/Organization	Status
MSHCP (2000)	Evaluation Species
U.S. Fish and Wildlife Service Endangered Species Act	None
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	Sensitive
State of Nevada	Protected
State of California	Species of Special Concern
State of Arizona	Species of Greatest Conservation Need
State of Utah	Species of Greatest Conservation Need
NV Division of Natural Heritage	At Risk
NV Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Presumed Stable
NatureServe Global and NV State Rank	G4 S2
IUCN Red List (v 2025-2)	Least Concern
CITES	None

Townsend's big-eared bat carries no listing status under the federal Endangered Species Act for western populations; however, two eastern subspecies, the Ozark big-eared bat (*C. t. ingens*) and the Virginia big-eared bat (*C. t. virginianus*, are federally listed as Endangered. The species was formerly considered a Category 2 candidate for federal listing, but this designation was dissolved in 1996 due to insufficient information (USFWS 1996). A petition to list all California populations was filed in 2012 by the Center for Biological Diversity, citing widespread population declines; the California Fish and Game Commission acknowledged that listing may be warranted at that time (SWECO 2018).

Globally, the species is ranked G4 (apparently secure) by NatureServe (2026), though the Nevada state rank is S2 (imperiled), reflecting its more limited and vulnerable status within the state. The species is classified as Least Concern on the IUCN Red List and has no CITES listing. In Nevada, Townsend's big-eared bat is state-protected under NAC 503.030.1 and is designated a Species of Greatest Conservation Need under the Nevada Wildlife Action Plan (NDOW 2022). The BLM and U.S. Forest Service (Region 4) both list the species as Sensitive in Nevada.

Population Trends

Townsend's big-eared bat is thought to be declining in abundance throughout much of its range. There is general concurrence among bat biologists that there has been a downward trend in abundance over the

past half-century in the western portion of the range (NatureServe 2026). NatureServe (2026) characterizes the long-term trend as a decline of 10 to 50 percent, with a short-term trend of decline of less than 30 percent to relatively stable, though monitoring at most roosts has been inadequate to detect trends with confidence. The total adult population size is uncertain but is estimated to exceed 10,000 individuals, and likely exceeds 100,000; the species is characterized overall by numerous relatively small colonies (NatureServe 2026).

Substantial documented declines have occurred in California, where surveys from 1987 to 1991 indicated a 52 percent reduction in numbers of maternity colonies and a 55 percent decline in number of individuals (Pierson and Rainey 1998). Major reductions of up to 59 percent occurred between 1987 and 1994 at hibernacula in south-central Idaho (NatureServe 2026). More recently, Idaho surveys conducted between 2003 and 2007 indicated a stable population across hibernation sites, with a total of at least 3,147 individuals counted across 9 sites in 2006, including up to approximately 1,800 individuals at a single site (NatureServe 2026). In Oregon, approximately half of the known colonies were believed to have been either extirpated or had experienced substantial decline in numbers. By contrast, some populations have remained stable or increased where effective conservation measures have been implemented, particularly in the eastern portion of the range.

In Nevada, Townsend's big-eared bats have declined by up to 50 percent in some portions of the state, with population declines attributed to chronic roost disturbance, hard mine closures, and closures without bat-compatible gates (NBWG 2024). The Nevada State Wildlife Action Plan characterizes the current trend as presumed stable (NDOW 2022). Protection of caves and mines through gating and seasonal cave closures has stabilized some populations. Maternity colony sizes in Nevada range from a couple dozen females to over 2,500 individuals, and hibernacula counts range from a few individuals to over 500 (NBWG 2024). Notably, mines are used more than caves as roosts in Nevada, which differs from patterns observed in other states where caves are preferred (NBWG 2024).

Little trend data are available specific to Clark County. Recent surveys along the Colorado River Corridor indicate the species is rare in that area; however, those surveys may not have overlapped with the typical foraging habitat for this species (Williams et al. 2006).

Habitat Level Threats

The primary threat to Townsend's big-eared bat habitat is disturbance and destruction of roost sites. In addition to urbanization, activities that can result in significant disturbance or loss of habitat include mine reclamation, renewed mining at historical workings, recreational caving, rock climbing, loss of building roosts, water impoundments, and bridge replacement (Kunz and Martin 1982; Pierson et al. 1999). Nevada has an abundance of former mining sites that serve as suitable roosts for this species, and the closure of mines without bat-compatible gates has been a significant driver of habitat loss in the state (NBWG 2024).

Habitat loss and degradation from timber harvesting and development can also negatively affect both roosting and foraging areas. Canopy cover in areas surrounding caves, rock faces, and other roost sites is important to maintain; heavy equipment and blasting near roost sites can also cause abandonment (NatureServe 2026). Reduction of the prey base through the widespread use of insecticides is suspected to contribute to insect biodiversity and abundance loss, potentially impacting this moth-specialist bat (NDOW 2022; Piaggio 2005). Although white nose syndrome, caused by the fungus *Pseudogymnoascus destructans*, has not yet been documented in Nevada, this disease has the potential to affect all

hibernating bat species and bat conservation programs in the state are actively monitoring for its presence (NDOW 2022). Renewable energy development, particularly wind turbines, can result in direct collision mortality for foraging bats; solar arrays may also disrupt foraging habitat (SWECO 2018). Gates installed to protect mines from human disturbance may interfere with local colony survivorship if not designed to be bat-friendly (Pierson and Rainey 1998).

Threats to Species

Townsend's big-eared bats are highly sensitive to roost disturbance and may abandon roost sites following human visitation. Disturbance at a nursery colony or a hibernating group may cause bats to abandon the site and move to an alternate roost, with potential loss of pups and energetic costs that can be difficult for small colonies to withstand (NatureServe 2026). Recreational caving and mine exploration, as well as resumed mining activities, represent the primary threats to this species in Nevada and Clark County (NDOW 2022; SWECO 2018). Nondestructive intrusion associated with research activities can also negatively affect local colonies; capture and handling of bats in nursery roosts may cause bats to vacate the site, and females exhibit high natal philopatry, meaning extirpated colony sites are unlikely to be naturally recolonized (NatureServe 2026).

White nose syndrome poses a potential future threat. Colonies of hibernating bats exposed to the causative fungus can suffer mortality rates of 81 to 97 percent, and the disease now occurs throughout much of the eastern portion of the range of Townsend's big-eared bat, including in caves used by the species (NatureServe 2026; SWECO 2018). Wind turbines can cause direct impacts to bats through collisions or barotrauma; while not currently considered a significant source of mortality for this species, this threat may increase as wind energy installations expand throughout the species' range (NatureServe 2026).

Pesticide contamination may threaten this species in agricultural areas, both through direct exposure and through reduction of its moth prey base (Geluso et al. 1976; Piaggio 2005). There is also some evidence that predation by rats may be suppressing certain populations (Fellers 2000). Poorly designed mine gates, while intended to reduce human disturbance, can restrict bat access and result in population decline if not properly engineered for bat passage; there is specific evidence of collisions of this species with bat gates, particularly involving younger animals (Diamond and Diamond 2014, cited in SWECO 2018).

Conservation and Management

Several conservation plans address the needs of Townsend's big-eared bat within and adjacent to Clark County. The Nevada Wildlife Action Plan designates Townsend's big-eared bat as a Species of Greatest Conservation Need and sets objectives for maintaining stable or increasing populations, including conducting bat surveys within mines and installing bat-friendly closure structures (NDOW 2022). The Nevada Bat Conservation Plan considers Townsend's big-eared bat populations and habitats a high priority for funding, planning, and conservation actions, and characterizes the species as imperiled or at high risk of imperilment (Bradley et al. 2006).

Townsend's big-eared bat is classified as a Very High Priority species under the Spring Mountain Conservation Agreement, developed among multiple agencies to provide long-term protection for rare and sensitive species in the Spring Mountains National Recreation Area. Conservation actions identified in that plan include developing a bat monitoring program emphasizing roost site and water source monitoring, developing and implementing a plan to protect bat roosts in mines and caves, and working

with volunteers to provide nest boxes for roosting bats to replace lost habitat (USFS et al. 1998, cited in SWECO 2018).

Townsend's big-eared bat is also an Evaluation Species under the Lower Colorado River Multi-Species Habitat Conservation Plan, which identifies conservation measures including conducting surveys and research to locate roost sites and better identify habitat requirements, creating suitable habitat near existing roost sites, and monitoring and adaptively managing created habitat (LCR MSCP 2004, cited in SWECO 2018).

Suitable habitat for Townsend's big-eared bat within the MSHCP Amendment Plan Area totals approximately 884,587 acres. Of this, 22,104 acres (2.5 percent) fall within the Impact Area. The majority of suitable habitat (608,424 acres, or 68.8 percent of the total) occurs on lands managed for resource conservation. The existing MSHCP Reserve System contains 3,980 acres (0.4 percent) of suitable habitat, while the MSHCP Amendment Reserve System Additions contribute an additional 85,800 acres, representing 9.7 percent of total suitable habitat within the Plan Area (Simandle and Nussear 2025).

Townsend's big-eared bat (*Corynorhinus townsendii*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	884,587	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	22,104	2.5%
Suitable Habitat in Lands Managed for Resource Conservation	608,424	68.8%
Suitable Habitat in the existing MSHCP Reserve System	3,980	0.4%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	85,800	9.7%

*Simandle and Nussear 2025

Clark County Survey Data

Townsend's big-eared bat is known to occur across the Mojave Desert Ecoregion, but specifics of its habitat use in the region are poorly known, and the locality database for this species has historically had fewer records than other bat species modeled in the area (SWECO 2018). Early observations documented the species near the eastern end of Lake Mead and in the Newberry Mountains (RECON 2000). Surveys along the Colorado River Corridor conducted in 2006 physically captured and acoustically recorded the species in the upper Muddy River, though the species was considered rare in that area and survey effort may not have overlapped with typical foraging habitat (Williams et al. 2006).

Passive acoustic surveys conducted in 2022 and 2024 detected Townsend's big-eared bat at a total of 29 survey locations across Clark County (SWCA 2025). Detections were primarily concentrated within lower-elevation warm desert riparian corridors along the Muddy River and at ephemeral springs located in mid-elevation foothills within pinyon-juniper woodland; acoustic detections at mid-elevation locations were likely associated with foraging or movement between roost and foraging locations (SWCA 2025). The species was also detected at two survey points within the Muddy River Riparian Reserve Unit (MR-02 and MR-04) during surveys conducted in 2022 (SWCA 2024). The results of these surveys confirm that Townsend's big-eared bat forages across a broad elevational gradient in Clark County, including warm desert riparian, montane riparian, and mixed woodland habitats.

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Spotted Bat (*Euderma maculatum*)

Species Overview

The spotted bat (*Euderma maculatum*) is a medium-sized vesper bat and one of the most visually distinctive bat species in North America. Three large white spots on a blackish dorsum, one over each shoulder and one over the rump, inspired the species' common name. The ears are pinkish-red and the largest of any North American bat species (NBWG 2024). Weight ranges from 9 to 18 g, forearm length 41 to 55 mm, ear length 32 to 50 mm, and wingspan 33 to 36 cm (NBWG 2024). Best (1988) reported that female forearms are significantly longer than those of males, averaging 52 mm and 50 mm, respectively. A circular, hairless patch approximately 10 mm in diameter is present in the throat area, typically not visible unless the head is tilted upward (Snow 1974, Watkins 1977).

The spotted bat is the only species in the genus *Euderma*, and no subspecies are recognized (Watkins 1977; NBWG 2024). The generic name *Euderma* combines Latin words meaning "good" or "beautiful" and "skin," while the specific epithet *maculatum* stems from the Latin word for "spotted" (NBWG 2024).

Spotted bats locate relatively large prey over relatively long distances (Woodsworth et al. 1981). They forage primarily on moths with body lengths of 5 to 12 mm and are aerial hawkers with no evidence of gleaning prey from surfaces (NBWG 2024; Leonard and Fenton 1983). Lepidopterans compose over 99 percent of the diet by volume, with owlet moths, lappet moths, and geometer moths representing the dominant prey items (Painter et al. 2009). Available data suggest that female spotted bats roost singly and do not form nursery colonies (Chambers et al. 2011). Colony sizes have been recorded at 1 to 30 individuals (NBWG 2024). The species has a slow reproductive rate, producing one pup per year, typically in June, limiting the potential for population recovery following declines (NBWG 2024). Spotted bats use crevices in tall, sheer cliffs with little vegetation, and foraging takes place in adjacent open habitats (Chambers et al. 2011; Gervais 2016). They are a cliff-roosting species and may fly up to 80 km (approximately 50 miles) in a single night from a day roost to foraging sites, though feeding sites are often within 10 km (about 6 miles) of the roost (Luce and Keinath 2007).

The spotted bat's echolocation calls have a characteristic frequency near 7 to 10 kHz, which is audible to humans. The low-frequency call reduces prey detection distance to moths and enhances the bat's ability to approach prey undetected. The low-frequency calls of spotted bats can be missed by acoustic

detectors if audio settings are not properly adjusted, or misidentified as non-bat noise during acoustic vetting (NBWG 2024). Commuting speeds over long distances have been measured at 30 to 53 km per hour, indicating the species is capable of rapid, sustained flight (Rabe et al. 1998, Chambers et al. 2011).

Range

Spotted bats are distributed across western North America, ranging from central Mexico north to southern British Columbia, Canada, and east through the western United States as far as Wyoming, Colorado, and western Texas (NatureServe 2026). In the United States, the range extends from Montana south through Arizona, New Mexico, and Texas (Chambers et al. 2011). The NatureServe global range extent is estimated at 200,000 to 2,500,000 km^2 (NatureServe 2026). Distribution is patchy and closely linked to the availability of suitable cliff roosting habitat and nearby water and foraging areas. The elevational range spans from below sea level to approximately 3,230 m (Luce and Keinath 2007).

Within Nevada, the spotted bat occurs in a wide variety of habitats from low desert scrub to high-elevation coniferous forests, across an elevational range of approximately 540 to 2,130 m (1,771 to 6,986 ft) (NBWG 2024). Distribution within the state is scattered and patchy, linked to the availability of cliff roosting habitat. Of documented occurrences in Nevada, 35 occur in the metropolitan areas of Reno and Las Vegas. All but one of these urban records were associated with buildings, suggesting that urban environments can provide suitable roosting sites in the absence of natural cliff features (Geluso 2000).

Within Clark County, the spotted bat has been recorded in the Las Vegas urban area and in the Muddy River drainage (Williams et al. 2006). The Nevada Natural Heritage database contains six records for spotted bat in Clark County: five in the Las Vegas area and one in the upper Moapa Valley (SWECO 2018). More recent acoustic surveys have detected the species at 14 locations across north-central Clark County, extending the documented distribution within the county (SWCA 2025).

Habitat Characteristics

Spotted bats occupy a wide variety of habitat types, from low-elevation desert scrub to high-elevation montane coniferous forests, provided that suitable roosting habitat is available (NDOW 2022). Habitats used include open ponderosa pine, pinyon-juniper woodland, canyon bottoms, riparian and river corridors, meadows, open pastures, and hayfields (NBWG 2024). Roosting habitat is the key limiting factor for this species; roosting occurs primarily in cracks and crevices in tall, sheer cliff faces with little associated vegetation (Wai-Ping and Fenton 1989; Pierson and Rainey 1998; Rabe et al. 1998; Chambers et al. 2011). Caves, mines, and buildings have also been documented as roost sites, particularly in winter or in urban settings (Geluso 2000; Sherwin and Gannon 2005; Chambers et al. 2011). Spotted bats tend to roost singly or in small clusters and are known to shift among various cracks and crevices within large cliff features (NDOW 2022).

Active foraging occurs in open terrain including meadows, forest clearings, open wetlands, and riparian corridors, often at heights of 10 to 15 m above the ground (NBWG 2024; NDOW 2022). In southern Nevada, spotted bats have been documented foraging over open riparian marshes and mesquite bosque, with acoustic activity over riparian marsh greater than that of any other bat species measured at the survey sites (Williams et al. 2006; NBWG 2024). Proximity to permanent water is an important habitat feature; the species has a high rate of evaporative water loss and will travel considerable distances to access reliable water sources (Snow 1974).

Spotted bats are known to begin foraging shortly after dark, often with relatively constant activity throughout the night, though some individuals have been documented foraging for part of the night before night-roosting for a few hours prior to returning to the day roost (Wai-Ping and Fenton 1989; Storz 1995; Rabe et al. 1998; Chambers et al. 2011). In southern Nevada, spotted bats have been observed at riparian foraging areas two to three hours after sunset and active well into the night (NBWG 2024). Foraging activity is not strongly affected by moonlight (Leonard and Fenton 1983; Wai-Ping and Fenton 1989). Mean foraging home range sizes for four individuals tracked in northern Arizona were estimated at approximately 297 km^2 (Chambers et al. 2011), and individuals have been documented traveling up to 43 km one-way from day roost locations to foraging areas (Rabe et al. 1998).

Seasonal distribution patterns are not well understood. In some areas, spotted bats may occupy higher-elevation coniferous stands in summer and move to lower elevations in late summer and early fall (Berna 1990; Geluso 2000; NDOW 2022). Winter roosting sites within Nevada are unknown; in other parts of the range, small numbers have been documented hibernating in caves or periodically arousing from torpor to forage and drink (Ruffner et al. 1979; Hardy 1941).

Habitat Suitability Model

Habitat suitability for the spotted bat in Clark County was modeled by Simandle and Nussear (2025) using an ensemble modeling approach without Clark County vegetation divisions. A vegetation-based model using Clark County classifications could not be developed due to insufficient occurrence data. The ensemble model demonstrated robust performance, with testing Area Under the Receiver Operator Curve and TSS values both equal to 1.0000, and a testing BI of 0.8129, indicating strong ability to discriminate suitable habitat. The continuous BI curve indicates that at habitat suitability estimates above approximately 80 percent, species presence is predicted at up to 30 times the rate expected at random (Simandle and Nussear 2025).

The top four most important predictor variables in the ensemble model were the coefficient of variation in minimum temperature (CVMinTemp), the first principal component of sand/silt/clay content (soil1), the fractional component of bare ground (bare), and the coefficient of variation of winter precipitation (wpcv) (Simandle and Nussear 2025). Habitat suitability is low when CVMinTemp is below approximately 2.2, with suitability increasing rapidly to a peak near 2.4 and then declining moderately. Suitability is highest in soils with low values of the soil1 principal component and declines rapidly with increasing values. For bare ground cover, suitability is very low when bare ground is less than approximately 85 percent and increases sharply to a maximum above that threshold. Suitability generally increases as the coefficient of variation of winter precipitation increases, though high confidence intervals preclude detailed interpretation of that variable (Simandle and Nussear 2025).

Areas of high habitat suitability for *Euderma maculatum* are somewhat narrowly distributed across Clark County and the buffered study area (Figure 4). The highest-suitability habitat is predicted near the Virgin River, the Muddy River, and the Meadow Valley Wash in northeastern Clark County. Patches of suitable habitat also occur in and around the City of Las Vegas. Outside the Clark County boundary, moderately suitable habitat is found adjacent to Lake Mead near the Million Hills area (Simandle and Nussear 2025). Simandle and Nussear (2025) caution that model variable interpretation should be approached carefully, as occurrence records are concentrated in and around the Las Vegas urban area, where the environmental variables used in the model are not well represented.

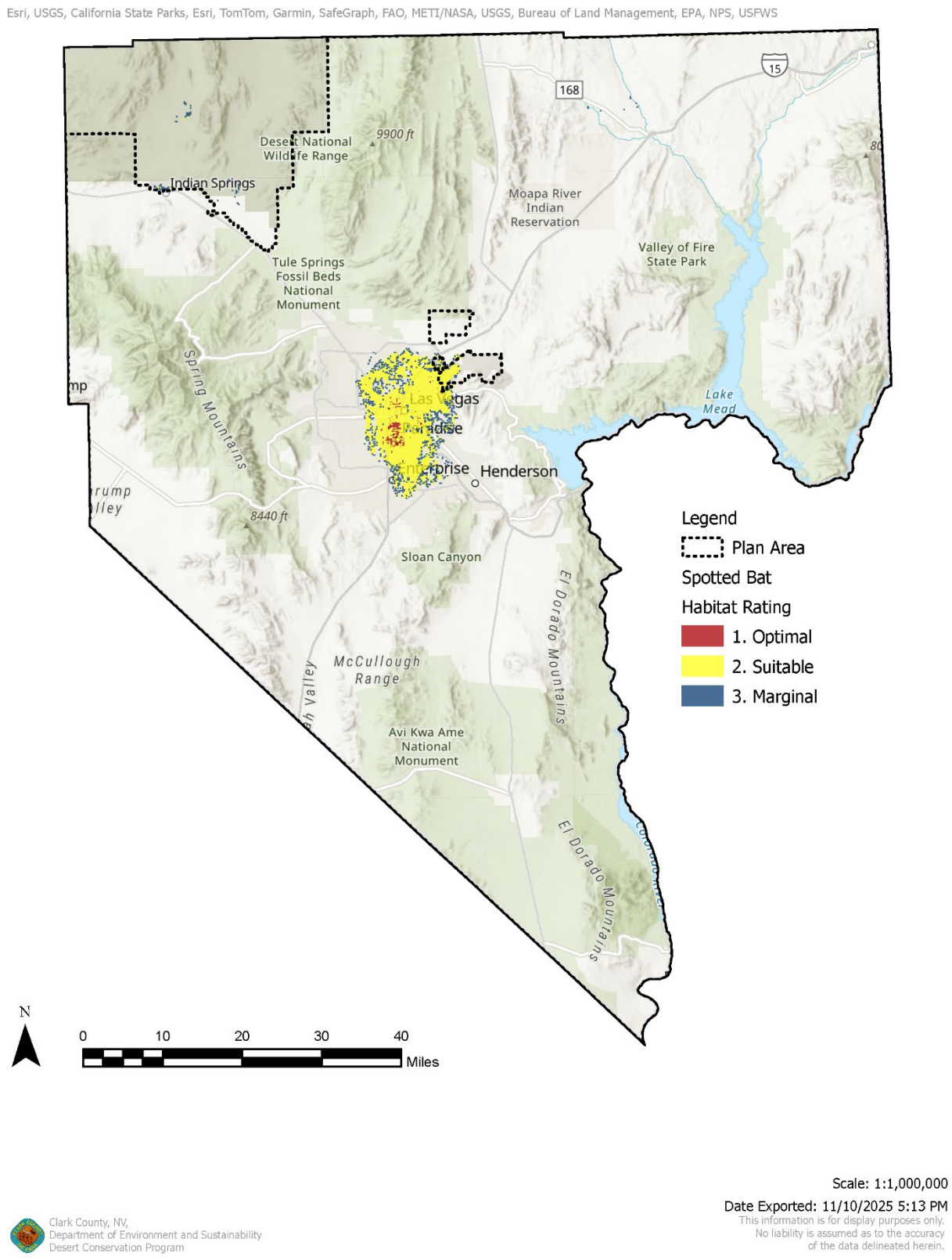

Figure 4. Habitat suitability model for spotted bat (*Euderma maculatum*) in Clark County, Nevada (Simandle and Nussear 2025).

Species Status

Agency/Organization	Status
MSHCP (2000)	Watch List
U.S. Fish and Wildlife Service Endangered Species Act	None
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	Sensitive
State of Nevada	Protected
State of California	Species of Special Concern
State of Arizona	Species of Greatest Conservation Need
State of Utah	Species of Greatest Conservation Need
NV Division of Natural Heritage	At Risk
NV State Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Presumed Stable
NatureServe Global and NV State Rank	G4 S2
IUCN Red List	Least Concern
CITES	None

The spotted bat carries no status under the federal Endangered Species Act and has not been the subject of a listing petition. It is classified as Sensitive by both the BLM (Nevada) and the U.S. Forest Service (Region 4), and is protected under Nevada state law pursuant to NAC 503.030.1 (NDOW 2022).

NatureServe assigns the spotted bat a global rank of G4 (Apparently Secure), reflecting a widespread but patchy distribution across western North America, an unknown but presumably substantial population size, and the absence of major known range-wide threats (NatureServe 2026). Within Nevada, the species is ranked S2 (Imperiled), indicating vulnerability at the state level due to its scattered and uncommon occurrence (NDOW 2022; NBWG 2024). In Canada, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designated the spotted bat as Special Concern in 1988, reconfirmed in 2004 and 2014, due to a patchy distribution, specialized roosting requirements, and a slow reproductive rate (NatureServe 2026).

The IUCN Red List categorizes the species as Least Concern based on its wide distribution, presumably large population, occurrence in protected areas, and absence of evidence of major population decline (Arroyo-Cabrales and Alvarez-Castaneda 2008). The species has no CITES listing. It was designated a Watch List species under the original 2000 MSHCP.

Population Trends

Little quantitative information is available on spotted bat population size or trends, either range-wide or within Nevada. NatureServe estimates the global adult population at between 2,500 and 100,000

individuals, but notes that the total is unknown (NatureServe 2026). The species was historically considered exceptionally rare; however, surveys using modern acoustic detection methods have demonstrated the species to be more widespread and numerous than previously believed, though it remains relatively uncommon (NDOW 2022; NBWG 2024). Capture rates across studies conducted in Nevada, California, and Arizona ranged from 0 to 4 percent of total bat captures, which may reflect true rarity, low capture efficiency due to the species' high-flying behavior, or both (NBWG 2024).

NatureServe characterizes the long-term population trend as uncertain, noting that distribution and abundance have likely not changed greatly from historical conditions. The short-term trend over approximately 10 years or three generations is assessed as relatively stable, with no more than 10 percent change (NatureServe 2026). The Nevada State Wildlife Action Plan similarly designates the trend as presumed stable, with distribution and abundance considered likely to have remained stable in recent years, and the Climate Change Vulnerability Index rating for the species is also presumed stable (NDOW 2022).

Presence-absence studies in New Mexico by Geluso (2006, 2017) documented continued occupancy at 11 of 13 historically known sites, suggesting local populations have persisted over time, though no population size estimates were generated (NBWG 2024). No Nevada-specific population data are available (NBWG 2024).

Monitoring this species presents particular challenges. The spotted bat tends to fly high and is therefore infrequently captured in standard mist nets; use of triple-high nets substantially increases capture success (NDOW 2022). The species is typically captured later in the evening than other bat species (NDOW 2022). Roost sites are generally dispersed and often not easily accessible (NDOW 2022; NBWG 2024). Acoustic detection using modern high-performance microphones and recording devices has proven more effective than netting for establishing distribution and occurrence (NDOW 2022), but requires careful calibration, as the low-frequency calls of spotted bats can be missed or misidentified if detector settings are not properly configured (NBWG 2024).

Habitat Level Threats

The primary habitat-level threats to spotted bats include loss or degradation of foraging areas, loss or modification of roosting sites, and reduction of prey availability. Loss of wet meadows, riparian corridors, and other open foraging areas through livestock grazing, water diversion, urbanization, and conversion to renewable energy facilities represent threats to foraging habitat quality and extent (Luce and Keinath 2007; NBWG 2024). Solar energy development in particular can eliminate large areas of foraging habitat in desert environments (SWECO 2018).

Cliff roosting habitat is generally considered extensive and remote, making it less susceptible to direct disturbance or destruction compared to many other bat roosting environments (NatureServe 2026). However, recreational rock climbing can disturb occupied roost crevices (NDOW 2022; SWECO 2018). Mining and quarry operations in areas with cliff formations may also result in roost loss (SWECO 2018). Urban development may remove cliff features in some areas, though spotted bats are known to use urban buildings as alternative roost sites.

Wind energy development poses a threat through both direct habitat disturbance and direct mortality from turbine collisions and barotrauma (Cryan and Barclay 2009; SWECO 2018). The Nevada State Wildlife Action Plan identifies persistent drought as a high-severity threat, as drought conditions are likely to impact the montane habitats this species relies on for foraging and roosting (NDOW 2022). Loss

of accessible open water sources is also a concern, given the species' high rate of evaporative water loss and its documented tendency to travel considerable distances to reach water (Snow 1974; SWECO 2018).

Threats to Species

The main threats to spotted bats as a species include habitat alteration affecting foraging areas, loss or modification of cliff roost sites, pesticide use, and the potential spread of white-nose syndrome (WNS) (NBWG 2024). Use of pesticides targeting lepidopterans may reduce prey availability and could result in secondary poisoning of spotted bats (NBWG 2024; NDOW 2022). Pollution and contamination of water sources may further reduce prey abundance and expose individual bats to toxins (Gervais 2016).

White-nose syndrome (WNS), caused by the fungus *Pseudogymnoascus destructans*, has the potential to impact this species as the disease continues to spread westward across North America (Gervais 2016). Spotted bats had not been confirmed infected with WNS as of the preparation of the original MSHCP Amendment Covered Species Report (SWECO 2018). Their solitary roosting behavior may reduce transmission risk relative to species that hibernate in large aggregations; however, WNS should be considered an ongoing potential threat.

Wind turbine collisions and barotrauma represent an additional threat to individual bats, though the range-wide scope of this threat is generally considered low (NatureServe 2026). Climate change, through its effects on prey availability, water availability, and habitat condition, is an emerging long-term concern for this and other bat species dependent on montane and riparian habitats in the Mojave Desert region (NDOW 2022).

The Nevada State Wildlife Action Plan (NDOW 2022) characterizes direct threats to the spotted bat by severity. Recreational rock climbing, which can disturb cliffs used for roosting, is identified as a low-severity threat. The widespread use of insecticides is classified as a medium-severity threat, with insecticide use suspected to be contributing to declines in insect biodiversity and abundance; secondary poisoning and reduced prey availability potentially impact insectivorous bat species. Persistent drought is identified as a high-severity threat, as drought conditions are likely to diminish the montane habitats that spotted bats rely on for both foraging and roosting (NDOW 2022).

Conservation and Management

Several conservation planning documents address the spotted bat within Nevada and Clark County. The Nevada State Wildlife Action Plan designates the spotted bat as a Species of Greatest Conservation Need, with the primary objective of maintaining populations at detectable levels (NDOW 2022). Recommended conservation actions include acoustic monitoring, radio-telemetry studies to identify roost sites, and promotion of water source availability (NDOW 2022).

The Nevada Bat Conservation Plan (NBWG 2024) identifies spotted bat populations and habitats as a medium conservation priority, noting that data gaps preclude a thorough assessment of the species' status. Research priorities identified in the plan include identification and description of roost sites, determination of breeding range, and documentation of distribution and seasonal movements within Nevada (NBWG 2024).

The spotted bat is covered under the Spring Mountain Conservation Agreement, a multi-agency agreement providing long-term protection for rare and sensitive flora and fauna of the Spring Mountains National Recreation Area. Conservation actions in that plan relevant to spotted bats include

development of bat monitoring plans emphasizing roost site and water source monitoring, mine and cave protection plans, and recreational impact monitoring (USFS et al. 1998).

The Overton Wildlife Management Area (OWMA) conceptual management plan identifies determination of spotted bat occurrence and assessment of habitat functionality within the OWMA as a management objective (NDOW 2014). The following table summarizes the acreage of modeled suitable habitat for the spotted bat within the MSHCP Amendment Plan Area, as estimated by Simandle and Nussear (2025).

Spotted bat (*Euderma maculatum*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	255,552	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	21,176	8.3%
Suitable Habitat in Lands Managed for Resource Conservation	50,114	19.6%
Suitable Habitat in the existing MSHCP Reserve System	2,653	1.0%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	6,793	2.7%

*Simandle and Nussear 2025

Clark County Survey Data

Early survey and occurrence data for Clark County are limited. The Nevada Natural Heritage database contained six records for spotted bat in Clark County as of the SWCA (2018) report: five in the Las Vegas urban area and one in the upper Moapa Valley (SWECO 2018). Geluso (2000) reported six records from urban buildings in Las Vegas. Williams et al. (2006) documented spotted bat acoustic activity in the upper Moapa Valley, where the species was observed primarily foraging over mesquite habitat along the Muddy River and secondarily over riparian marsh.

A qualitative habitat model developed by SWECO (2018) for the original MSHCP Amendment analysis concluded that approximately 9,144 km^2 of high and moderate suitability habitat exists within the county, with an estimated 3 percent of modeled habitat potentially subject to impacts from covered activities. Most suitable habitat was found outside the planning area.

SWCA Environmental Consultants conducted passive acoustic surveys in 2022 and 2024 on behalf of the Clark County Desert Conservation Program (SWCA 2025). These surveys detected spotted bats at 14 locations across north-central Clark County, including survey locations within and adjacent to the OWMA, the Muddy River drainage, the Warm Springs area, Bitter Spring, and the Gold Butte area. Detection habitats included warm desert riparian woodland, emergent marsh, and agricultural fields, primarily alfalfa. Spotted bat recordings, including feeding trills indicative of active foraging, were obtained at survey sites MO-1, BI-1, BI-2, GB-4, OW-2, OW-3, and OW-4, suggesting repeated foraging activity and/or multiple individuals at these locations across several detector-nights (SWCA 2025). At two survey locations (BR-1 and MU-1), lower detection rates suggest the bats were passing through or exhibiting lower-intensity use (SWCA 2025). The majority of detections within Clark County are associated with the OWMA and adjacent riparian corridors along the Muddy River (SWCA 2025).

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Species Accounts
Birds

Golden Eagle (*Aquila chrysaetos*)

Photo Credit: Justin Streit, SWCA

Photo Credit: Justin Streit, SWCA

Species Overview

The golden eagle (*Aquila chrysaetos*) is one of North America's largest raptors, with a wingspan up to 222 cm (over 7 feet) and body mass up to 6.5 kg (over 14 pounds; Katzner et al. 2020). The species has a circumpolar distribution across the northern hemisphere (Bent 1961). Adults are dark brown with a characteristic golden wash on the back of the neck and yellow bill and feet; there are no plumage differences by sex, but females are larger than males. Juveniles are largely similar to adults but display variable patches of white at the base of the tail and on the underwing. As is true of all 'booted' eagles, golden eagles have feathered legs extending to the feet (NDOW 2022).

Golden eagles are a highly territorial, long-lived, and often intolerant of human disturbance (Katzner et al. 2020). Resident pairs maintain long-term pair bonds and large home ranges with little overlap between territories. Courtship begins in December or January, and the breeding season can span from December through July in Nevada. The species builds large stick nests generally on ledges, cracks, and outcrops found on cliffs and rocky faces, but also occasionally on trees (e.g., ponderosa pine, juniper, quaking aspen) and power poles. Known golden eagle nests in Clark County are all on cliff substrate (NDOW 2022). Nests are large structures, often several feet thick from accumulated materials, and pairs maintain one to 18 alternate nests per territory (Kochert and Steenhof 2012). Most eagle nests command a broad view of the surrounding landscape. Egg laying and incubation peak by the third week of February across Nevada, with hatching peaking in early April and nestlings fledging mainly from late May through mid-July (NDOW 2022). Breeding attempts generally consist of one to two eggs per year, and incubation lasts approximately 41 to 45 days (Kochert et al. 2002). Golden eagles are known to forego breeding in years with low prey availability, and breeding success and productivity are negatively correlated with reduced prey availability and poor weather conditions (Katzner et al. 2020; NDOW 2022). Full adult plumage is not acquired until approximately four years of age, and the species typically does not first breed until its fourth or fifth year.

Golden eagles are carnivores with a diet dominated by small to medium-sized mammals. In Nevada, primary prey consists of black-tailed jackrabbits and cottontail rabbits, with at least 24 other species documented opportunistically, including various ground squirrels, yellow-bellied marmots, mourning doves, ravens, mid-sized raptors, snakes, lizards, and even young mule deer and pronghorn (NDOW 2022). Golden eagles also scavenge carrion from roadkill and other sources.

Mean annual survival rates range from 0.69 in first-year eagles to 0.89 in adults (Millsap et al. 2022). Golden eagles can live more than 30 years in the wild; however, increased first-year mortality and various natural and anthropogenic mortality causes result in only about 25 percent of individuals surviving to at least six years of age (Harmata 2002). Key limiting factors for populations include prey availability and suitable nest site availability near adequate prey base (GBBO 2010).

Range

Golden eagles have a broad, nearly global distribution. Currently, golden eagle populations in North America are most robust west of the Great Plains, with additional populations in northeastern Canada and isolated locations in the eastern United States (Kochert et al. 2002, DeLong 2004). In North America, breeding occurs from western and northern Alaska eastward through the Northwest Territories to Labrador, and south to northern Mexico, Texas, western Oklahoma, and western Kansas (NatureServe 2026). The species generally favors relatively open landscapes including grasslands, shrublands, and mountainous terrain, and avoids densely forested areas and large agricultural or urban areas. The winter range in North America extends from south-central Alaska and southern Canada southward through the breeding range, and the species is most numerous in winter in the Rocky Mountain states, the Great Basin, and the western edge of the Great Plains (NatureServe 2026). In hot desert regions, most eagles vacate desert basins during summer.

In Nevada, golden eagles are widely distributed as a breeding species wherever suitable nesting and foraging habitat is present (NDOW 2022). Territory-holding adults are largely found in mid-elevation mountainous areas with cliffs, while nonbreeding adults and younger age classes can be found anywhere from valley bottoms to high-elevation tundra, including various agricultural areas (NDOW 2022). Numbers in Nevada during the winter months are likely augmented by migrants from more northerly latitudes.

In Clark County, golden eagles nest in limited numbers throughout. Every major mountain range and several smaller ones are occupied by resident golden eagles (NDOW unpublished raptor nest database). Multiple nests are known from the Spring Mountains, Newberry Mountains, and McCullough Mountains, among others (Nussear 2020). Mojave Desert scrub habitats in the valley bottoms and outwash plains comprise a great deal of the foraging areas, as do mountain slopes and peaks (Nussear 2020). Known adjacent nests in Clark County are considerably further apart than typical inter-nest distances reported in the literature, reflecting the lower density and vast open terrain of the Mojave Desert region (Nussear 2020). Foraging has been documented in most habitat types in Clark County, and golden eagles have been observed flying directly over the city of Las Vegas (Nussear 2020).

Habitat Characteristics

Golden eagles generally inhabit open and semi-open country such as prairies, sagebrush shrublands, arctic and alpine tundra, savannah or sparse woodland, and barren areas, especially in hilly or mountainous regions where sufficient mammalian prey and suitable nesting sites are available (NatureServe 2026). In Nevada, the only habitats routinely avoided by golden eagles are forests, large

agricultural areas, and urban areas (GBBO 2010). Major habitat types used in Nevada include salt desert shrub, low-elevation sagebrush-dominated shrubland, Mojave mid-elevation mixed desert scrub, Mojave warm desert, montane shrublands, and cliffs and canyons (NDOW 2022).

Nesting habitat requires cliffs or other elevated substrates with commanding views of the surrounding landscape. In Clark County, all known nests are located on cliff substrate (Nussear 2020). Modeled nesting habitat in Clark County is largely associated with Mojave Desert Scrub and Blackbrush ecosystems, restricted to mountains and cliffs within those broader landscape types (Nussear 2020). Breeding season territories range in size from 20 to 54 km² in most of the species' range, though in the Mojave Desert of southern California, golden eagle home ranges have averaged approximately 308 km² (Braham et al. 2015). In high-density populations with abundant nest substrate and prey, occupied nests may be situated as closely as less than 1 km between neighboring pairs (Kochert et al. 2002), but known adjacent nests in Clark County are considerably further apart than documented elsewhere (Nussear 2020).

Foraging habitat in Clark County encompasses most habitat types occurring across the county. Expansive Mojave desert scrub habitats in the valley bottoms and outwash plains, as well as mountain slopes and peaks, represent primary foraging areas (Nussear 2020). Prey base studies and recent satellite tracking data indicate that territory-holding adults in Nevada are largely sedentary within their home range, while younger age classes and non-breeding adults make regional movements throughout the Great Basin, Intermountain West, and into southern Canada and northern Mexico (NDOW 2022).

Habitat Suitability Model

The habitat suitability model for golden eagle was developed by Nussear et al. (2024) using an ensemble modeling approach based on golden eagle nesting site localities. Ensemble models were constructed using Gradient Boosting Machine (GBM), Random Forest (RF), Generalized Additive Model (GAM), and MaxEnt (MX) algorithms. Performance of the ensemble model was strong overall (AUC = 0.99, BI = 0.97, TSS = 0.94 for the model without the vegetation layer), indicating excellent discriminatory ability.

Variable importance analysis indicated that slope, average spring maximum temperature, and topographic index were the most influential variables in predicting golden eagle nesting habitat, each contributing 39 percent or more to at least one of the modeling algorithms (Nussear et al. 2024). Distance to cliffs had the lowest contribution, which was contrary to expectations given the species' reliance on cliff-based nesting substrate. Models incorporating a vegetation layer showed moderate dependence on that variable (approximately 7 to 8 percent importance), and produced a more spatially constrained habitat prediction relative to models without the vegetation layer.

Vegetation associations at golden eagle locality points were largely composed of North American Warm Desert Scrub and Grassland, and Western North American Cool Semi-Desert Scrub and Grassland (Nussear et al. 2024). High-suitability nesting habitat within Clark County is predicted to occur primarily within mountain ranges and cliff-bearing terrain in association with Mojave Desert Scrub and Blackbrush ecosystems (Figure 5; Nussear 2020). The habitat model predicts only nesting habitat; foraging areas are understood to include expansive open areas throughout the county. Within Clark County, a total of approximately 128,419 hectares of nesting habitat are predicted, of which approximately 2,190 hectares (1.7 percent) are within the impact area and approximately 33,790 hectares (26.3 percent) occur within conserved areas (Nussear 2020).

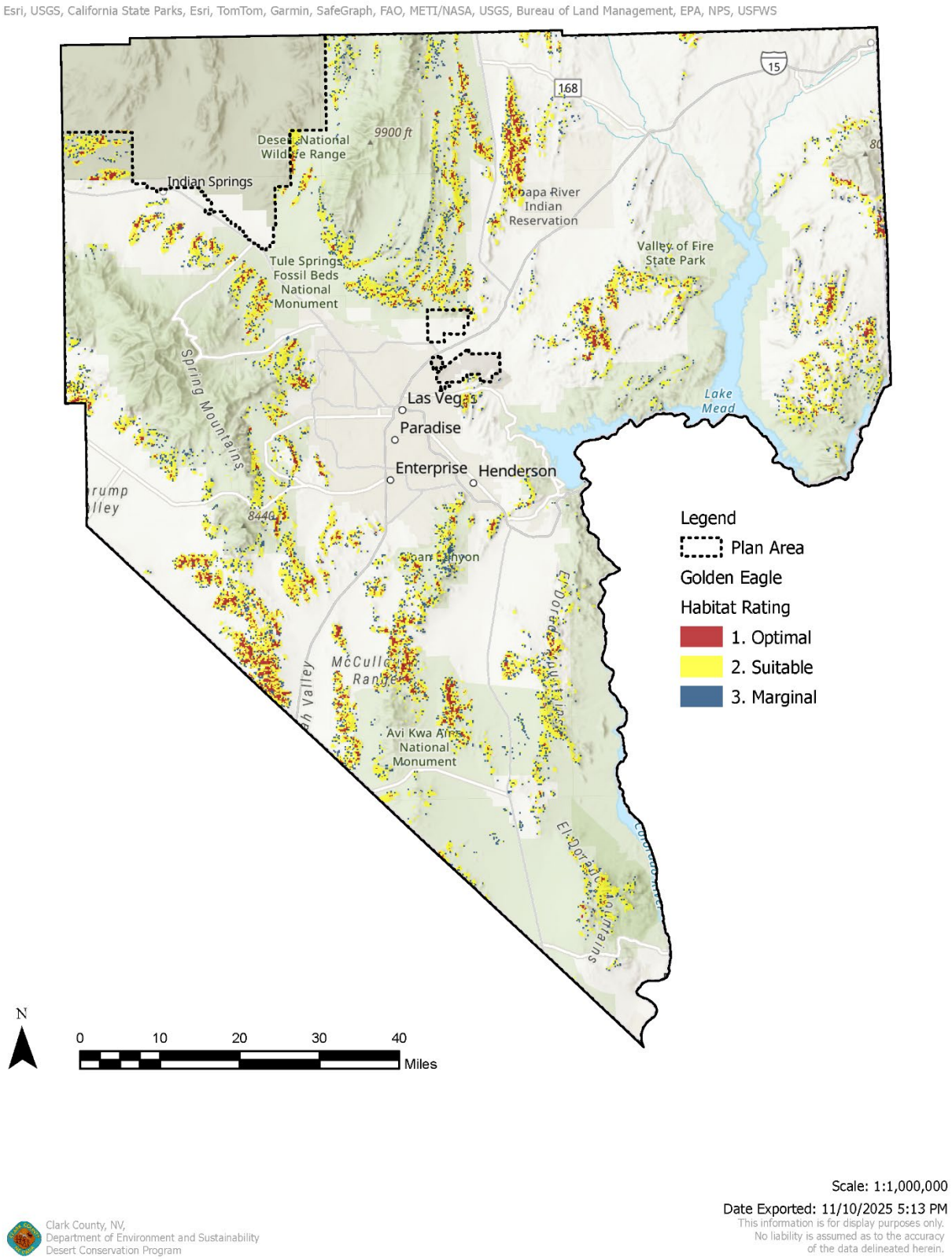

Figure 5. Habitat suitability model for golden eagle (*Aquila chrysaetos*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Watch List
U.S. Fish and Wildlife Service Endangered Species Act	No Status
Bald and Golden Eagle Protection Act	Protected
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	No Status
State of Nevada	Sensitive
State of Arizona	Species of Greatest Conservation Need
State of California	State Fully Protected
State of Utah	Species of Greatest Conservation Need
NV Division of Natural Heritage	Watch List
NV State Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Presumed Stable
NatureServe Global and NV State Rank	G5 S4
IUCN Red List	Least Concern
CITES	Appendix II

The golden eagle is federally protected by the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, and the Lacey Act. The Bald and Golden Eagle Protection Act prohibits the take, possession, import, export, and commerce of golden eagles without a permit.

The species is considered globally secure, with a NatureServe Global Status of G5, reflecting its wide distribution throughout the Northern Hemisphere. The global population was estimated at approximately 170,000 individuals, with roughly half occurring in the United States and Canada (Rich et al. 2004). In North America, an earlier estimate placed the population at approximately 70,000 individuals, including perhaps 20,000 breeding pairs in the western United States (NatureServe 2026). In Nevada, the species holds an S4 state rank, indicating it is apparently secure statewide (NatureServe 2026; NDOW 2022). Golden eagle is listed on CITES Appendix II, meaning international trade is regulated but the species is not necessarily threatened with extinction. The IUCN Red List classifies the golden eagle as Least Concern globally.

In a 2025 petition finding, the USFWS determined that listing the eastern population of the golden eagle under the Endangered Species Act was not warranted, concluding that the best available information indicates populations are stable rangewide and within the eastern portion of the range (USFWS 2025).

Population Trends

The overall population trend for golden eagle is presumed stable at broad scales, but trends at finer geographic scales present a more complicated picture. Breeding Bird Survey data from 1993 to 2019 showed no significant change in golden eagle abundance rangewide, though nonsignificant downward trends were detected in Nevada and the broader Great Basin, Mojave, and Sonoran desert regions during the same period (Sauer et al. 2019). NatureServe (2026) notes that after several decades of relative stability, golden eagle numbers may again be declining in the West, particularly in the sage-steppe region (GBBO 2010). In eastern North America, the species may also be decreasing in the northeastern United States (Bednarz et al. 1990), and declines have been noted in parts of the Canadian range (Kirk et al. 1995).

Golden eagle populations in the West remain reduced from pre-Columbian levels due to several historical factors. Organized predator and prey control programs operated throughout much of the region for nearly a century, including use of poisoned baits and active shooting campaigns. Historical egg collection for oology is considered to have had a localized but detrimental influence on populations near heavily populated areas in California and elsewhere. In addition, the era of bounty-driven eradication campaigns in the early 1900s resulted in broad persecution of the species. Golden eagles were also targeted because of a perceived, though largely overstated, threat to livestock. While those large-scale organized threats have been substantially reduced, they resulted in population-level losses from which recovery has been incomplete in some portions of the range (Nussear 2020).

Population trend estimation for golden eagles is inherently challenging due to the species' wide-ranging behavior, use of remote terrain, and large home ranges. Large-scale survey efforts tend to produce estimates with wide margins of error. A survey of golden eagles in 12 western states estimated a total population of approximately 27,392 individuals (with a 90 percent confidence interval of 21,352 to 35,140), though large portions of the West, including most of California, southern Nevada, southern Arizona, and southern New Mexico, were not included in that survey (Good et al. 2007). Golden eagle populations also appear to fluctuate in association with approximately 10-year cycles in prey abundance (Nielson et al. 2013).

In Nevada specifically, statewide trends are presumed stable but remain poorly characterized due to the absence of large-scale breeding population monitoring (NDOW 2022). Localized territory monitoring conducted from 2015 to 2021 documented annual territory occupancy exceeding 97 percent, but also steep declines in breeding success and productivity (NDOW 2022). Estimated mean annual survival rates range from 0.69 in first-year eagles to 0.89 in adults; Nevada-specific satellite tracking data from 2014 to 2021 produced similar estimates, with first-year survival at 0.68 and survival after the third year at 0.85 (NDOW 2022). A west-wide survival analysis found that while populations are broadly stable, 74 percent of mortalities are attributable to anthropogenic causes, and additional anthropogenic mortality could render populations unsustainable (Millsap et al. 2022). These data suggest a stable adult breeding population but with very limited juvenile survival and recruitment, raising concerns about long-term population replacement (NDOW 2022).

Habitat Level Threats

Golden eagle habitat faces a range of direct and indirect threats. Renewable energy development represents one of the most significant and growing threats. Wind turbines pose a direct collision and mortality risk to golden eagles; while wind energy facilities are not currently a major factor in Clark

County, their expansion has been proposed for desert areas in the region (Nussear 2020). Large-scale solar energy projects, typically sited in basin areas, do not pose direct disturbance or mortality risk to nesting eagles, but prolific new development (often exceeding 20,000 acres per project group) eliminates previously suitable foraging habitat, reducing prey availability and increasing the area eagles must traverse to meet foraging needs (NDOW 2022).

Urban and suburban development encroaches on foraging habitat across Clark County and has been associated with the abandonment of historically used golden eagle nests in other areas (Phillips 1986; GBBO 2010). Subsidized predator populations (e.g., ravens and coyotes) near expanding urban boundaries may reduce the prey base available to golden eagles (Nussear 2020). Mining operations in Nevada can have very large footprints, eliminating nesting substrate and foraging habitat, generating disturbance from blasting, and increasing road traffic and power infrastructure in previously remote areas (NDOW 2022).

Wildfire represents an additional habitat-level threat. Large-scale fires in desert and sagebrush habitats can reduce jackrabbit and other prey populations by eliminating shrub cover. Conversion of native sagebrush and pinyon-juniper habitat to exotic annual grasslands further degrades both nesting and foraging opportunities (NDOW 2022). Climate change is considered a high-level threat, with persistent drought degrading suitable habitat and reducing prey populations, and increased incidence of extreme temperatures and unpredictable storm events negatively impacting nesting attempts (NDOW 2022).

Threats to Species

Primary direct threats to golden eagles at the individual and population level in Clark County include the following:

Electrocution and collision with utility infrastructure: Golden eagles are vulnerable to electrocution when their large wingspans span phase-to-phase or phase-to-ground conductors on small or poorly configured power poles (APLIC 2006). This risk is particularly elevated in rural areas with older, non-retrofitted utility lines. Collision with transmission wires also poses a mortality risk. While electrocution rates may have declined in recent decades due to utility retrofitting efforts, risk remains substantial on older rural power infrastructure in Nevada (Nussear 2020). Notably, one study of 126 eagle carcasses recovered along power lines found that 84 percent had been killed by gunshot rather than electrocution, underscoring that intentional persecution remains a significant mortality source even in areas with high infrastructure risk (Olson 2001).

Vehicular collision: Eagles feeding on road kill are at elevated risk of vehicular strikes, particularly during winter months and for younger, less experienced individuals (NDOW 2022).

Secondary poisoning: Ingestion of lead shot and rodenticides presents a significant threat. Two of three eagles tracked by USGS in Clark County in 2015 died prematurely; both had measurable rodenticide levels in their systems, and one died in a vehicle collision on Interstate 15 south of Mountain Pass, California (Nussear 2020). Misuse of insecticides and non-target poisoning of eagles consuming rodenticide-laced prey has reduced eagle populations and remains a concern.

Rabbit Hemorrhagic Disease Virus type 2 (RHDV2): This non-native virus can heavily impact lagomorph (jackrabbit and cottontail) populations, which are the primary prey base for golden eagles in Nevada. Widespread RHDV2 outbreaks represent a substantial secondary threat to golden eagles through prey base reduction (NDOW 2022).

Renewable energy development: Wind turbine blade strikes are well-documented as a source of golden eagle mortality at existing facilities, and expansion of wind energy into Clark County would increase this risk (Nussear 2020). Large-scale solar installations reduce foraging habitat available to eagles, potentially requiring larger home ranges and exposing eagles to more risk factors (NDOW 2022).

Human disturbance: Human activity near active nests may cause nest abandonment, reduce nest productivity, or prevent suitable nest sites from being used (GBBO 2010). While most nesting areas in Clark County are remote, some are in proximity to human recreation sites.

Conservation and Management

The golden eagle is afforded federal protection under the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act, and the Lacey Act. Take of golden eagles requires a permit from USFWS, making incidental take authorization a key consideration for development projects in Clark County.

The 2022 Nevada State Wildlife Action Plan considers golden eagle a Species of Greatest Conservation Need and recommends protection of nesting and roosting sites, research into non-lethal wind turbine designs, continuation of helicopter surveys to monitor the population, and additional studies on territory density, site persistence, and impacts of drought and reduced lagomorph availability on breeding success (NDOW 2022). The Nevada Comprehensive Bird Conservation Plan designates golden eagle as a Conservation Priority Species and recommends managing habitats to encourage healthy prey populations, using Eagle Guards on transmission lines, and burial of mining drip lines to minimize poisoning risk (GBBO 2010). Partners in Flight has established a Nevada population objective for the golden eagle to increase the statewide population from 6,200 to 6,800 individuals (Rosenberg 2004a).

The table below summarizes the acreage of suitable golden eagle habitat within the MSHCP Amendment Plan Area.

Golden eagle (*Aquila chrysaetos*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	450,388	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	8,473	1.9%
Suitable Habitat in Lands Managed for Resource Conservation	302,852	67.2%
Suitable Habitat in the existing MSHCP Reserve System	425	0.1%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	29,097	6.5%

*Nussear et al. 2024

Clark County Survey Data

Localized territory monitoring in Nevada from 2015 to 2021 indicated annual territory occupancy greater than 97 percent, but with steep declines in breeding success and productivity (NDOW 2022). Satellite tracking data from Nevada from 2014 to 2021 estimated first-year survival at 0.68 and after-third-year survival at 0.85, with 74 percent of mortalities attributed to anthropogenic causes (Millsap et al. 2022, as cited in NDOW 2022).

SWCA conducted focused surveys for golden eagle in Clark County in 2021 and 2022 (SWCA 2021, 2022). In 2021, surveys documented 14 golden eagle detections across 10 sites. Four detections occurred in the MSHCP Amendment Reserve System: two within the Boulder City Conservation Easement and two in proposed reserve system additions. All other detections were on federally managed lands. These detections formed a diagonal band across southern Clark County from Pahrump Valley to the Colorado River, with sporadic detections in the northern and central portions of the county (SWCA 2021). Of the 18 total detections reported, 12 (67 percent) were within predicted foraging habitat; given the highly mobile nature of the species and an average detection distance of 1,976 m, telemetry was recommended to further refine foraging habitat use in the county (SWCA 2021).

In 2022, golden eagles were detected 12 times at 30 surveyed sites across Clark County (SWCA 2022). Four of the 12 detections involved two individuals soaring together. All detected individuals were in flight; no active foraging behavior was observed during any detection. Nine of 11 detections within the county (82 percent) were within predicted foraging habitat, with six detections (55 percent) in habitat modeled as optimal and three (27 percent) in habitat modeled as suitable; two detections were outside predicted foraging habitat. Detections were concentrated in the vicinity of the Spring Mountains and Sheep Mountains, with one individual performing undulating, territorial flight in suitable foraging habitat (SWCA 2022). The average estimated detection distance was 2,693 m (range 150 to 10,000 m), underscoring the difficulty of accurately locating individuals through ground-based counts. Signs of potential prey (leporid mammals) were recorded in 12 subplots classified as unsuitable foraging habitat, suggesting that golden eagles may forage over a broader area than currently predicted (SWCA 2022). SWCA (2022) recommended that telemetry and prey-base surveys be incorporated in future efforts to more accurately characterize foraging habitat use in Clark County.

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Western Burrowing Owl (*Athene cunicularia hypugaea*)

Photo credit: Kimberley Goodwin, Clark County

Photo credit: Kimberley Goodwin, Clark County

Species Overview

The western burrowing owl (*Athene cunicularia hypugaea*) is a small, long-legged, short-tailed, and mostly diurnal species found in open desert and grassland habitats (NDOW 2022). It favors open, arid, treeless landscapes with low vegetation and occurs across a range of lower-elevation habitat types, including sagebrush scrub, sagebrush steppe, salt desert scrub, and the grasslands of the Great Basin and Mojave deserts. The species also adapts well to human-modified environments and frequently nests near roadsides, airports, golf courses, parking lots, and agricultural fields.

Although burrowing owls rely on underground refugia, they do not dig their own burrows and instead depend on those created by other animals (Floyd et al. 2007). In the northern part of their range, they rely heavily on prairie dog (*Cynomys* spp.) colonies, while in the south they use burrows made by ground squirrels, skunks, and foxes. In the Mojave and Sonoran deserts, they also occupy desert tortoise (*Gopherus agassizii*) burrows (Klute et al. 2003; McDonald et al. 2004).

Movement patterns vary geographically: northern populations are migratory, while southern U.S. and northern Mexico populations include both residents and winter visitors, and farther south into Mexico and Central America only wintering owls are present.

Range

The western burrowing owl is one of two subspecies of burrowing owl found in the United States. The western subspecies ranges across most of western North America from south-central Manitoba south to Brownsville, Texas, west to the California coast, and north to southern British Columbia (Neel 1999).

In southern Nevada, the species breeds locally, with some individuals remaining year-round while most migrate to the southern United States and Mexico during winter (Haug et al. 1993). Northern and central Nevada populations are migratory, arriving on breeding grounds in February through March and departing in September through October. Southern Nevada supports both year-round resident and wintering populations (NDOW 2022).

In Clark County, owl distribution closely overlaps that of the Mojave desert tortoise due to shared use of burrows. Although densities are generally low in desert scrub habitats, higher numbers have been documented in areas such as Gold Butte, Piute Valley, the eastern slopes of Eldorado Valley, and the

western bajadas of Lake Mohave within Lake Mead National Recreation Area (Crowe and Longshore 2010b). Burrowing owls have also been documented breeding in isolated desert patches within urban landscapes. The USFWS Urban Burrowing Owl Monitoring Project reported a relatively high number of breeding owls in northern Las Vegas Valley, with some nesting in man-made structures (Manville 2009).

Habitat Characteristics

The western burrowing owl is associated with open, arid, and treeless landscapes throughout Clark County. The species occurs across a variety of lower-elevation vegetation communities including intermountain cold desert scrub, sagebrush steppe, salt desert scrub, grasslands, and Mojave scrub, as well as some developed landscapes (Haug et al. 1993; Johnsgard 2002; Wildlife Action Plan Team 2012). A strong preference for open areas with low perennial vegetation cover is consistent with a need for visibility during foraging and detection of predators near burrow sites.

Because the species does not excavate its own burrows, suitable nesting habitat requires the presence of an existing burrow-providing mammal community. In the Mojave Desert, this association is dominated by Mojave desert tortoise burrows, making burrowing owl distribution within Clark County largely contingent on desert tortoise habitat (Klute et al. 2003; McDonald et al. 2004). Earlier species distribution modeling for the Mojave Desert confirmed positive associations with winter and summer precipitation and negative associations with slope and perennial cover (Crowe and Longshore 2010a).

Burrowing owls are fairly tolerant of human disturbance and will breed around the margins of agricultural lands, using crops and pasture areas for foraging during the breeding season (Neel 1999). In suitable urban contexts, they respond positively to habitat enhancement such as installation of artificial nest burrows.

Habitat Suitability Model

Habitat suitability for the western burrowing owl in Clark County was modeled by Nussear et al. (2024) using an ensemble approach combining GAMs, RF, and MaxEnt algorithms, based on 382 point localities distributed largely in a north-to-south band through the center of the county. The ensemble model achieved strong predictive performance, with an AUC of 0.96, a BI of 0.89, and a TSS of 0.82. The RF algorithm had the highest individual performance of the three algorithms (AUC = 0.98; TSS = 0.90).

Topographic position index (TPI) was the single most influential variable across algorithms, reflecting the species' preference for valley floors and bajadas rather than slopes or ridge positions. Winter minimum temperature was the second most influential variable overall, with suitability increasing strongly above 0°C. Slope had a strong negative relationship with predicted habitat, with habitat scoring as unsuitable in areas with greater than 5 degrees of slope. Additional contributing variables included surface texture (reflecting finer-grained soils associated with sand and loam), annual heat/moisture index, winter precipitation, and summer maximum temperature.

The ensemble model predicts suitable habitat throughout southern and northeastern Clark County, concentrated in valley floors and bajadas. Areas of highest predicted suitability include the northern Las Vegas Valley, Eastern Eldorado Valley, Ivanpah Valley, most of Piute Valley, the bajadas above Laughlin, Cottonwood Cove to Nelson corridor, and Apex. Moderate to high suitability is also predicted along the Interstate 15 corridor, through Moapa Valley, Mormon Mesa, the Virgin and Muddy River valleys, the valley east of Searchlight extending to the Colorado River, and Gold Butte. The model predicts approximately 1,947 km^2 of high-quality habitat, 4,707 km^2 of medium-suitability habitat, and 13,111

square kilometers of lower-quality habitat within Clark County (Nussear et al. 2024). See Figure 6 for the habitat suitability map for the western burrowing owl.

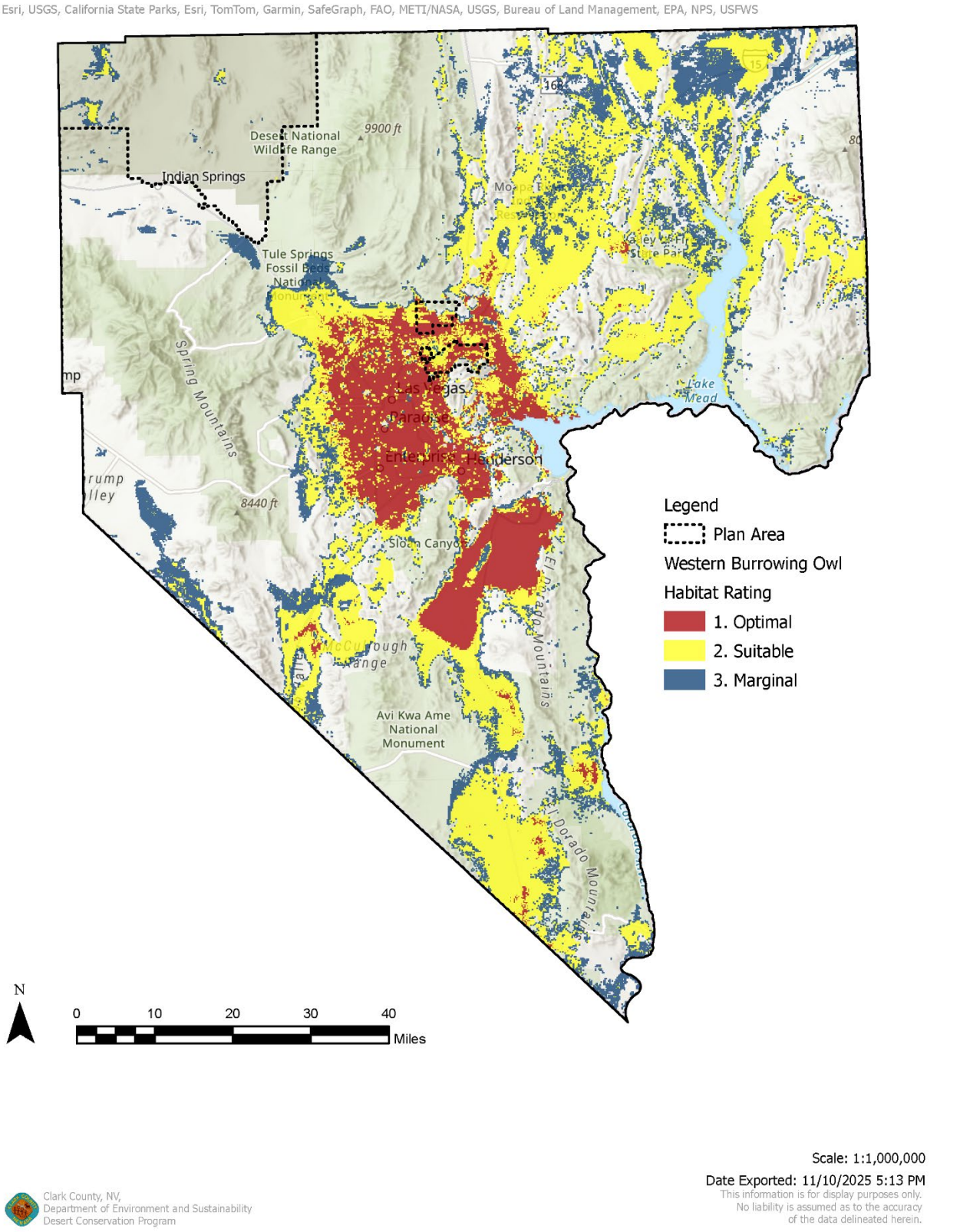

Figure 6. Habitat suitability model for western burrowing owl (*Athene cunicularia hypugaea*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Evaluation
U.S. Fish and Wildlife Service Endangered Species Act	None
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	None
State of Arizona	Species of Greatest Conservation Need
State of California	State Candidate Endangered, Species of Special Concern[1]
State of Utah	Species of Greatest Conservation Need
NV Division of Natural Heritage	Watch List
NV State Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Presumed Stable
NatureServe Global and NV State Rank	G4T4 / S3B
IUCN Red List	Least Concern[1]
CITES	Appendix II[1]

[1] Listed as *Athene cunicularia*

The western burrowing owl was classified by USFWS as a Category 2 candidate for consideration for listing under the Endangered Species Act from 1994 to 1996, before this candidate category was discontinued in 1996 without listing (SWECO 2018). The species is currently designated as a Bird of Conservation Concern by USFWS within the Mojave Desert Bird Conservation Region (USFWS 2008) and is protected under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703-712). At the state level, the species is listed as endangered in Minnesota, threatened in Colorado and Florida, and as a species of concern in California, Montana, Oklahoma, Oregon, Utah, Washington, and Wyoming (USFWS 2026).

The species is assigned a global conservation status of G4T4 (Apparently Secure subspecies) by NatureServe, based on a review last updated in April 2016 (NatureServe 2026). At the state level in Nevada, the species carries a rank of S3B (Vulnerable, breeding) and is a protected bird under NAC 503.050.1 (NDOW 2022). The BLM in Nevada designates the species as Sensitive. The species is listed on CITES Appendix II and is assessed as Least Concern on the IUCN Red List, both as *Athene cunicularia* at the species level (McDonald et al. 2004).

Population Trends

Population trends for the western burrowing owl have been consistently negative across much of its range. NatureServe (2026) characterizes the long-term trend as a decline of 50 to 90 percent rangewide,

with the short-term trend described as a decline of 10 to 50 percent. No western state or province has reported an increasing population (NatureServe 2026). At the national level, the Partners in Flight Landbird Conservation Plan estimated a 35 percent decline in burrowing owl populations across the United States between 1970 and 2014 (Rosenberg et al. 2016).

Regional declines have been severe and well-documented. Over the past century, population declines exceeding 50 percent have been estimated for British Columbia, Alberta, California, Nevada, Colorado, and New Mexico (NatureServe 2026). In California, 60 percent of known breeding groups disappeared between the 1980s and 1990s, and the species has been extirpated from four coastal California counties (NatureServe 2026). In Canada, Saskatchewan's Operation Burrowing Owl documented an 87 percent decline in site occupancy and an 88 percent decline in the number of pairs between 1988 and 1997 (NatureServe 2026).

Results from the North American Breeding Bird Survey for the Great Basin, Sonoran, and Mojave desert regions for the periods 1966 to 2019 and 1993 to 2019 are described as inconclusive for Nevada specifically (Sauer et al. 2020). The western burrowing owl appeared on the Audubon Society Blue List of declining bird populations beginning in 1972 but was removed from this list in 2007 (Audubon Society 2007).

Population trend in Nevada is currently listed as unknown (NDOW 2022). Surveys in the state are generally limited to presence-absence surveys conducted during pre-clearance for proposed projects as part of the NEPA process. Information is lacking about how habitat loss, urban conversion, and control or extermination of colonial burrowing mammals affect the species in Nevada, and little is known about migration patterns or wintering habitat of Nevada populations (NDOW 2022). Earlier transect surveys in Clark County documented an average of 0.12 owl territories per square kilometer, nest success of approximately 60 percent, and approximately three fledged young per nesting attempt (Crowe and Longshore 2010b).

Habitat Level Threats

Burrowing owls are declining throughout much of North America, with declining populations and range contractions documented across southern Canada, the Great Plains, and many western states. These declines are associated with habitat loss and fragmentation due to agricultural and urban development (Sheffield 1997; Millsap and Bear 2000). Large-scale renewable energy development for solar and wind generation represents a more recent and growing source of habitat loss through surface disturbance and soil compaction across broad areas of desert scrub habitat (SWECO 2018).

The dependence of burrowing owls on other fossorial species for burrow sites creates an indirect habitat threat through the decline of those species. In the Mojave Desert, Mojave desert tortoise populations are also in decline, which may have a cascading negative effect on burrowing owl nest site availability (Tracy et al. 2006). In the Great Plains portion of the species' range, documented declines have been correlated with the decline of prairie dog colonies, although prairie dogs do not occur in Clark County (Haug et al. 1993; Desmond et al. 2000).

Because the species demonstrates a strong preference for open, sparsely vegetated substrates, habitat degradation through invasive annual grass establishment and resultant increases in vegetation density and fire frequency may reduce habitat quality over time. Although short-term increases in open ground following fire or heavy grazing may temporarily benefit the species, the net effects of these disturbances on desert systems are considered negative (Klute et al. 2003).

Additional habitat-level threats include off-road vehicular activity, which degrades open desert substrates and destroys active burrows, and the loss of foraging habitat from encroachment of invasive annual grasses following fire (Wildlife Action Plan Team 2012). Climate change leading to increased fire frequency, spring heat waves, drought, and flooding may also negatively impact burrowing owl populations and habitat quality (USFWS 2026).

Threats to Species

In addition to habitat-level threats, several direct threats affect western burrowing owl populations. Rodenticides used for control of mammal species are ingested by burrowing owls both directly and through secondary poisoning and represent a significant source of direct mortality (Klute et al. 2003). Predation from domestic and feral cats (*Felis catus*) and dogs (*Canis familiaris*), vehicle collisions along roads adjacent to nesting areas, and pesticide exposure are additional documented mortality sources (Klute et al. 2003; NDOW 2022).

The tendency of burrowing owls to colonize urban margins and areas with man-made structures increases exposure to covered activities within Clark County. Urban-nesting pairs are subject to direct loss from construction and ground disturbance associated with development, and urban edge habitat is among the most intensively developed within the MSHCP Amendment Impact Area.

Conservation and Management

The western burrowing owl is protected under the Migratory Bird Treaty Act, which prohibits take of the species, its eggs, and active nests without a federal permit. A national conservation plan was developed by USFWS (Klute et al. 2003), with primary management actions including maintaining large, contiguous areas of suitable habitat; enhancing habitat features through installation of artificial burrows, elevated perch sites, and maintenance of short vegetation; conserving mammalian species that provide nest sites; supporting reintroduction or re-occupation of suitable but under-occupied habitats; and increasing public education and awareness.

In Nevada, the species is addressed in the Nevada State Wildlife Action Plan (NDOW 2022) and the Nevada Comprehensive Bird Conservation Plan (GBBO 2010). Recommended actions in these plans include establishing effective monitoring programs to determine population status and trends; maintaining short vegetation and healthy prey populations near known colony locations; enforcing a no-disturbance buffer zone of 60 meters (200 feet) around active nest burrows; providing artificial burrows to help restore populations; and discouraging the use of pesticides within 600 meters of nest burrows. The Nevada Wildlife Action Plan also recommends conservation of burrowing mammal colonies and protection of nesting areas and burrows from disturbance during incubation and nesting.

The western burrowing owl is additionally addressed in the Nevada Partners in Flight Bird Conservation Plan (Neel 1999), the Spring Mountains Conservation Agreement (USFS et al. 1998), and the conceptual management plan for the OWMA, which recommends determining the extent of burrowing owl occurrences at the management area and providing artificial burrows if warranted (NDOW 2014).

Western burrowing owl (*Athene cunicularia hypugaea*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	1,656,382	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	160,620	9.7%

Suitable Habitat in Lands Managed for Resource Conservation	637,421	38.5%
Suitable Habitat in the existing MSHCP Reserve System	77,420	4.7%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	88,908	5.4%

*Nussear et al. 2024

Clark County Survey Data

The earliest systematic survey effort targeting burrowing owls in Clark County was conducted by Crowe and Longshore (2010a, 2010b) using modified transect survey techniques developed for the Mojave Desert. These surveys, conducted over a two-year period, documented relative abundances of owls in areas throughout the county and recorded an average of 0.12 owl territories per square kilometer, nest success of approximately 60 percent, and approximately three fledged young per nesting attempt (Crowe and Longshore 2010b). Higher numbers of owls were recorded at Gold Butte, Piute Valley, the eastern slopes of Eldorado Valley, and bajadas on the western side of Lake Mohave within Lake Mead National Recreation Area (Crowe and Longshore 2010b). No owls were detected in blackbrush or pinyon-juniper habitats during these surveys.

The USFWS Urban Burrowing Owl Monitoring Project, sponsored jointly with the Red Rock Audubon Society, was established as a three-year program to determine the success of burrowing owls nesting within the Las Vegas Valley. Preliminary results from this effort indicated that burrowing owls successfully breed within some urbanized areas of Las Vegas, with some pairs documented nesting in man-made structures including holes under sidewalks (Manville 2009). The relative success of urban-nesting pairs compared to non-urban pairs had not yet been determined at the time of reporting.

The Clark County Desert Conservation Program contracted avian surveys in 2021 and 2022 (SWCA 2021, 2022). In 2021, SWCA Environmental Consultants conducted three rounds of area-search surveys at 30 randomly selected sites distributed across MSHCP Amendment Impact Areas, the Amendment Reserve System, and other federally managed lands in Clark County between March 27 and June 11, 2021 (SWCA 2021). Western burrowing owl was one of seven target species surveyed. References to predicted habitat in the 2021 and 2022 survey summaries below reflect the initial habitat suitability model developed by SWECO (2018), the model in use at the time surveys were conducted. Detection data from both survey years subsequently informed development of the updated habitat model by Nussear et al. (2024), described in the Habitat Suitability Model section above. Of the 60 subplots surveyed in 2021, 31 (52 percent) intersected predicted suitable habitat for western burrowing owl under the SWECO (2018) model, with 1 subplot (2 percent) intersecting habitat modeled as optimal, 22 (37 percent) intersecting suitable habitat, and 8 (13 percent) intersecting marginal habitat.

Surveyors recorded a total of four western burrowing owl detections in 2021: two during an area-search survey and two incidental detections. The two survey detections were of owls observed together within a single subplot at the Needles Highway site, which was the only subplot intersecting habitat modeled as optimal for the species under the SWECO (2018) model. The two incidental detections were made outside predicted habitat, at distances of 10 meters and 815 meters from the nearest predicted habitat boundary. Surveyors also identified a possibly occupied burrow at the Sandy Valley site; the burrow exhibited whitewash and a pellet near the entrance but was filled with spiderwebs on both the first and second survey visits, and no owls were observed there across any of the three survey rounds. This

burrow was located more than 9 kilometers outside predicted habitat. Three of the four owl detections were within MSHCP Amendment Impact Areas. The highest breeding behavior recorded was “pair in suitable habitat,” associated with one of the incidental detections (SWCA 2021).

Although owl detections were limited, habitat observations indicated that burrows of sufficient size to support burrowing owls were present in 50 of 60 subplots (83 percent), including many subplots outside predicted habitat boundaries. The limited number of detections relative to the prevalence of suitable burrows may partly reflect the severe drought conditions during the survey period. Clark County and the broader Southwest experienced prolonged drought during 2020 to 2021, with a record 240 consecutive days without measurable precipitation recorded in Las Vegas between April 20 and December 17, 2020, and the 2021 water year remained well below average. Drought is known to reduce prey availability and depress owl detectability. The results suggest that the SWECO (2018) habitat model may underestimate the presence of western burrowing owl habitat in Clark County, as owls and potentially occupied burrows were found in locations well outside predicted habitat boundaries; however, the small sample size precludes definitive conclusions (SWCA 2021).

In 2022, SWCA conducted a second round of avian surveys at 30 sites across Clark County between March 23 and June 5, 2022 (SWCA 2022). The surveys covered 569.3 hectares across 66 subplots, with eight sites having three square subplots and the remaining 22 sites having paired square or linear subplots and an eagle-use count location. Western burrowing owl was one of seven target species, and eight of the 30 sites contained at least one subplot selected specifically for burrowing owl; these eight sites encompassed 25 subplots totaling 185 hectares of predicted burrowing owl habitat (33 percent of the total area surveyed) under the SWECO (2018) model. Of the predicted habitat surveyed, 65 hectares were classified as optimal, 76 hectares as suitable, and 44 hectares as marginal.

Surveyors recorded only two western burrowing owl detections in 2022, one during an area-search survey and one incidental detection, making it the least frequently detected of all seven target species that year (SWCA 2022). Both detections were of calling individuals. One detection was in predicted suitable habitat (within the Lovell Wash site); the other was in habitat classified as unsuitable under the Southwest Ecology (2018) model, located approximately 217 meters from the nearest predicted marginal habitat boundary (at the Lower Meadow Valley Wash site). One of the two detections was more than 2.5 kilometers from existing detections in the model input dataset. Each detection occurred at a different site. The highest breeding behavior recorded for any detection was “calling,” representing only observed status with no evidence of breeding (SWCA 2022).

Habitat observations in 2022 mirrored those from 2021 in revealing a substantial mismatch between predicted habitat boundaries under the SWECO (2018) model and the distribution of potentially suitable burrows. Burrows of sufficient size to support burrowing owls were recorded in 38 of 66 subplots (58 percent), covering 328 hectares, which substantially exceeded the extent of predicted burrowing owl habitat (185 hectares; 33 percent of the total area surveyed). Of the subplots with burrows, 15 (totaling 121 hectares) were within predicted burrowing owl habitat. At the sites with associated burrowing owl detections, both subplots at one site had predicted habitat and potential burrows, while the subplots at the other site had predicted habitat but no recorded burrows. The two years of survey results, taken together, suggest that western burrowing owl may use more habitat in Clark County than the SWECO (2018) model predicted, as detections and potentially occupied burrows occurred in locations outside predicted habitat boundaries in both 2021 and 2022 (SWCA 2021, 2022).

The low number of detections in 2022 is likely attributable to multiple factors. The 2020 to 2022 period represents the driest two-year stretch on record for Clark County, with only 12.8 centimeters of precipitation recorded from July 2020 through June 2022, compared to a mean of 38.1 centimeters for the same period from 1901 through 2000 (NOAA 2022). Drought conditions are directly linked to reduced burrowing owl occurrence probability in Clark County, winter and summer precipitation were identified as positive predictors of species occurrence in earlier species distribution modeling (Crowe and Longshore 2010a), and depressed prey availability under drought conditions is expected to reduce both detectability and site occupancy. An additional factor is that burrowing owls away from developed areas are not habituated to human presence and may disappear into burrows before being detected by surveyors, potentially resulting in lower detection rates than expected even where owls are present (SWCA 2022).

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Yellow-billed Cuckoo (*Coccyzus americanus*)

Photo Credit: Brian Small Photography

Photo Credit: Justin Streit, SWCA

Species Overview

The yellow-billed cuckoo (*Coccyzus americanus*) is a medium-sized, secretive Neotropical migratory songbird in the family Cuculidae. It is approximately 31 centimeters in length and weighs approximately 64 grams. The species is grayish-brown above and white to buffy below, with a long black tail bearing prominent white spots on the ventral surface. The inner wing feathers are rufous in color. The bill is long and curved, with a distinctive yellow lower mandible and black upper mandible. Both sexes look alike. The species has zygodactyl feet (two toes pointing forward, two backward). It is most often detected by its distinctive call, as individuals will sit hidden in vegetation for extended periods (Hughes 2015; NDOW 2022).

The yellow-billed cuckoo is widespread throughout temperate North America during the breeding season and winters primarily in South America east of the Andes. The species is divided into two subspecies: the eastern subspecies (*C. a. americanus*) and the western subspecies (*C. a. occidentalis*). The taxonomic status of these subspecies has been the subject of ongoing debate; however, they are most recently treated as a single species (Payne and Sorensen 2005). Western populations are more limited in distribution and have experienced severe declines, primarily due to the loss and degradation of riparian habitat (Hughes 2015).

The yellow-billed cuckoo is an insectivorous species, feeding primarily on caterpillars, as well as other insects, small lizards, frogs, and occasionally bird eggs. Breeding often coincides with an increase in large insect abundances, such as outbreaks of cicadas or caterpillars. Clutch size ranges from one to five eggs, but is commonly two to three, and can be larger when prey is abundant. Incubation lasts 9 to 11 days, with both the male and female sharing incubation duties. Nestlings fledge 7 to 9 days after hatching (Hughes 2015; NDOW 2022).

In the western United States, the yellow-billed cuckoo arrives on breeding grounds in mid to late May, with greater numbers arriving in June. Migration to wintering grounds in South America typically occurs in late August (Hughes 2015).

Range

The yellow-billed cuckoo breeds throughout much of North America, from interior California to southern Idaho, southeastern Montana, the Dakotas, Minnesota, and New Brunswick, south through Mexico, the U.S. Gulf Coast, and Florida, and into the Greater Antilles. Breeding Bird Survey data indicate the species is most abundant in the south-central United States. The species is more common east of the Rocky Mountains; western populations have been substantially reduced due to the loss and degradation of riparian habitats (NatureServe 2016; Hughes 2015).

The western Distinct Population Segment (DPS) of the yellow-billed cuckoo, listed as threatened under the Endangered Species Act, encompasses parts of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Texas, Utah, Washington, and Wyoming, as well as portions of Canada and Mexico. The western DPS formerly ranged throughout much of the western United States but is now largely confined to small pockets of breeding birds in California, southern Nevada, Arizona, and New Mexico, where they inhabit riparian woodlands and scrub habitat along major rivers (Payne and Sorensen 2005).

Within the western DPS, populations have been largely extirpated or reduced to very small numbers across much of the historical range. In the Pacific Northwest, the western yellow-billed cuckoo is considered extirpated as a breeder in British Columbia and Washington, and if breeding persists in Oregon, pairs likely number in the single digits. Idaho and Wyoming each support fewer than 10 to 20 estimated breeding pairs, primarily in the Snake River and Green River Basins, respectively. The California population has declined by more than 99 percent from historical levels, with statewide numbers likely below 40 to 50 pairs at core sites along the Sacramento River, South Fork Kern River, and the lower Colorado River. Arizona holds the largest breeding population within the United States, estimated at a minimum of 350 territories excluding the lower Colorado River. Western New Mexico supports an estimated 190 to 235 breeding pairs, primarily along the middle Rio Grande. The total breeding population north of the Mexican border is estimated at 350 to 495 pairs, with an additional 330 to 530 pairs breeding in northwestern Mexico (USFWS 2020).

Within Nevada, USFWS (2020) concluded that fewer than 10 breeding pairs occur statewide. Historically, the species is thought to have been found statewide in appropriate riparian habitat, with evidence of past nesting along the lower Truckee and Carson Rivers in western Nevada and along the Colorado and Virgin Rivers in southern Nevada. Sporadic breeding events have been confirmed within various woody riparian areas in southern Nevada, including the Muddy and Virgin Rivers, while breeding has been suspected but not confirmed at additional locations (NDOW 2022).

Within Clark County, very little suitable cuckoo habitat remains due to land conversion for agriculture and urban development. The yellow-billed cuckoo is a very rare summer resident in the county, with only two known confirmed breeding locations: one along the Virgin River and one at the upper Muddy River, the latter now within a property owned by the Southern Nevada Water Authority (McKernan and Braden 2001; Floyd et al. 2007). The species has also been detected at Corn Creek and at Las Vegas Wash, though breeding has not been confirmed at those sites. The USFWS designated critical habitat for the western DPS of the yellow-billed cuckoo; however, none was designated in Nevada. The three critical habitat units associated with Clark County total approximately 13,000 acres, with the Virgin River Unit partially extending into Arizona.

Habitat Characteristics

The yellow-billed cuckoo is a riparian obligate species, requiring relatively large patches of intact gallery riparian habitat. In the southwestern United States, yellow-billed cuckoos prefer to nest in low-elevation riparian habitat consisting of open woodlands with dense understory vegetation. The species depends on large tracts of riparian forest and shows a strong preference for nesting in areas with at least 10 hectares (24.7 acres) of contiguous forest (Wiggins 2005). Optimal patches are generally greater than 81 hectares (200 acres) in extent, with sites of 41 to 80 hectares considered suitable and sites smaller than 15 hectares considered unsuitable (Laymon and Halterman 1989). Canopy closure is also critical: sites with less than 40 percent closure are unsuitable, those with 40 to 65 percent are marginal to suitable, and those with greater than 65 percent are optimal (Laymon 1998).

In the West, nesting is primarily in thick willows (*Salix* spp.), while cottonwoods (*Populus* spp.) are used for foraging. Yellow-billed cuckoos have been observed using stands of mixed tamarisk (*Tamarix* spp.) and native vegetation, though monocultures of tamarisk provide suboptimal habitat (Sogge et al. 2008). The species has a highly irruptive behavior, presumably tied to prey availability, with low site fidelity between years, making survey efforts and population estimates challenging (NDOW 2022).

Habitat Suitability Model

Habitat suitability for yellow-billed cuckoo within Clark County was modeled by Simandle and Nussear (2025) using an ensemble modeling approach. Performance metrics for the ensemble model indicate a robust model, with near-perfect discrimination (AUC = 1.000 for both training and testing data sets) and threshold-based accuracy (TSS = 1.000). Calibration was strong, with a BI of 0.951 for training data and 0.802 for testing data. The continuous BI curve indicates that predicted suitability values exceeding approximately 75 to 80 percent correspond to species presence substantially above random expectation (Simandle and Nussear 2025).

Several variables were identified as particularly influential in the ensemble model. Shrub fractional cover was the most broadly important predictor, appearing in three of the four component models; suitability is very low below 25 percent shrub cover and increases sharply above that threshold. Absolute minimum temperature was important in two models, with suitability peaking near -5 degrees Celsius and declining at warmer minimum temperatures. The first principal component of soil texture (capturing sand, silt, and clay gradients) was also important in two models, with suitability highest when this value is below zero. The coefficient of variation of minimum temperature was important in one model, with low suitability below a value of 2 and rapid increases as variability rises (Simandle and Nussear 2025).

High-suitability habitat for yellow-billed cuckoo within Clark County is narrowly distributed, reflecting the species' riparian dependence. The highest suitability values are predicted in areas near the Meadow Valley Wash, the Muddy River, and the Virgin River. A patch of suitable habitat is also predicted across portions of the City of Las Vegas and adjacent areas of Las Vegas Wash as it joins Lake Mead. Additional highly suitable habitat is predicted along the Colorado River and Lake Mojave, continuing through the Bullhead City area and into Mohave Valley, Arizona, as well as smaller areas in Coyote Springs Valley, Indian Springs Valley, and Pahrump Valley (Simandle and Nussear 2025). See Figure 7 for the habitat suitability model.

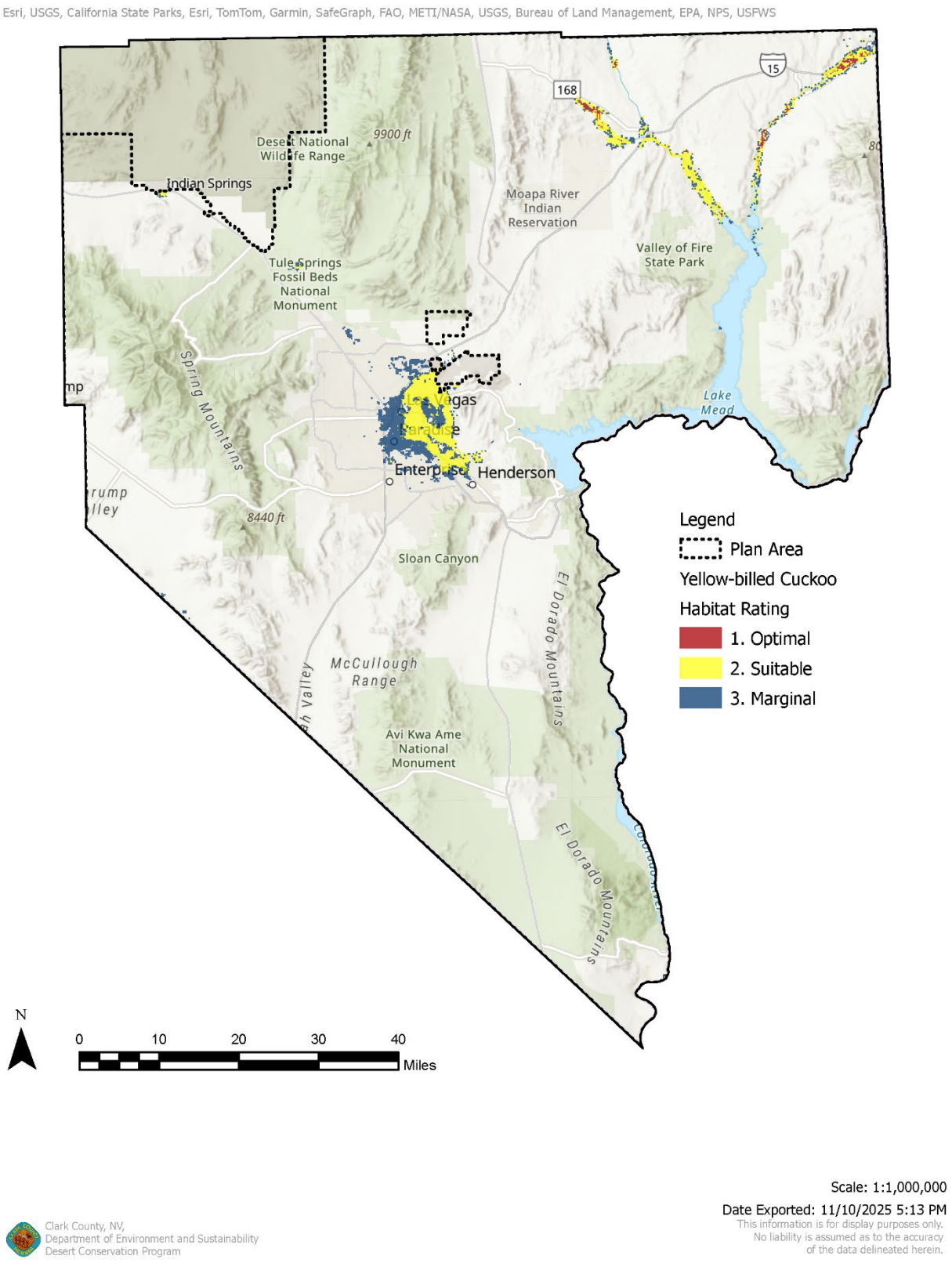

Figure 7. Habitat suitability model for yellow-billed cuckoo (*Coccyzus americanus*) in Clark County, Nevada (Simandle and Nussear 2025).

Species Status

Agency/Organization	Status
MSHCP (2000)	Covered
U.S. Fish and Wildlife Service Endangered Species Act	Threatened
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	Threatened
State of Nevada	Threatened
State of Arizona	Species of Greatest Conservation Need
State of California	State Endangered
State of Utah	Species of Greatest Conservation Need
NV Division of Natural Heritage	At Risk
NV State Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Moderately Vulnerable
NatureServe Global and NV State Rank	G5 S1B
IUCN Red List	Least Concern
CITES	No Status

The western DPS of the yellow-billed cuckoo was listed as threatened under the Endangered Species Act on November 3, 2014 (Federal Register 79 FR 59991). The listing history dates to a 1986 petition to list the species as endangered in California, Washington, Idaho, Oregon, and Nevada; that petition was denied because the petitioned area did not encompass a recognized subspecies or DPS. A subsequent petition filed in 1998 to list the western yellow-billed cuckoo as a DPS was found warranted but precluded from 2001 to 2013. Critical habitat was proposed in 2014, with three critical habitat units associated with Clark County. As of this writing, a recovery plan has not been published. In 2020, the USFWS reviewed a petition to delist the western DPS and found that delisting was not warranted at that time (USFWS 2020).

NatureServe (2026) assigns the full species a global rank of G5 (Secure), reflecting the large and widespread eastern population. However, the western DPS of *C. a. occidentalis* is ranked S1B in Nevada, reflecting its critically imperiled breeding status in the state. The IUCN lists the species as Least Concern, consistent with its broad global distribution and large population size. The species has no CITES status.

Population Trends

Western populations of the yellow-billed cuckoo are in serious decline. An estimated 59 percent population decline was recorded rangewide from 1970 to 2014 (Rosenberg et al. 2016). Major declines have been reported by multiple sources over the last century (Alcorn 1988; Hughes 2015; McKernan and Braden 2001; Wiggins 2005; Johnson et al. 2007). Survey data compiled by the USFWS (2020) estimated the total current breeding population at only 680 to 1,025 pairs across the entire western range

including northwestern Mexico, representing a reduction of several orders of magnitude from historical levels.

The North American Breeding Bird Survey has been insufficient to detect this species at a level adequate to establish reliable trends within the Mojave and Sonoran Desert region (Sauer et al. 2019). At the national level, Breeding Bird Survey data indicate a significant long-term abundance decline of approximately 1.7 percent per year from 1966 to 2007, with the rate increasing to 2.1 percent per year from 1980 to 2007 (NatureServe 2016). The species is identified on the Yellow Watch List as a species with a demonstrated need for population recovery in North America (Rosenberg et al. 2016).

State-level survey data summarized by USFWS (2020) illustrate the severity of declines across the western range. In California, the population fell from an estimated 15,000 pairs historically to likely fewer than 40 to 50 pairs at three core sites along the Sacramento River, South Fork Kern River, and lower Colorado River, representing a decline of more than 99 percent. In Arizona, populations declined from an estimated 846 pairs on the lower Colorado River and five major tributaries in 1976, with the most recent available estimates indicating a minimum of approximately 350 territories rangewide; Arizona nonetheless retains the largest remaining breeding population in the United States. Survey results from the middle Rio Grande in New Mexico document a decline from an estimated 315 breeding pairs in 1984 to 91 to 116 pairs in recent survey years. These declines are attributed to habitat loss, altered hydrological regimes, prolonged drought, and continued threats on wintering grounds (USFWS 2020).

In Nevada, fewer than 10 breeding pairs are estimated to occur statewide, and population trends are considered presumed declining (NDOW 2022; USFWS 2020). The species' irruptive behavior and low site fidelity between years make it very difficult to assess population density and habitat occupancy.

Habitat Level Threats

Ecosystem-level threats facing yellow-billed cuckoo habitat include habitat fragmentation and loss driven by land conversion, water management, and vegetation changes. Principal causes of riparian habitat loss are conversion to agricultural and other uses, dams and river flow management, stream channelization and stabilization, and livestock grazing (Wiggins 2005; Nevada Partners in Flight 1999). Altered hydrological regimes, including groundwater pumping and dewatered stream segments resulting from drought and upstream diversions, further reduce the availability and quality of riparian habitat (NDOW 2022).

Habitat degradation from invasive plants, particularly tamarisk (*Tamarix* spp.), is a significant threat. Tamarisk can replace multi-layered riparian forest structure with a single monotypic layer, degrading conditions for nesting and foraging. The spread of defoliating tamarisk beetles poses an additional risk by potentially reducing the structural complexity that tamarisk-containing habitats may otherwise provide (NDOW 2022). Any restoration or eradication plan must account for the potential loss of habitat for breeding cuckoos during transitional periods (Sogge et al. 2008).

Increased fire frequency resulting from altered fire regimes can also impact local breeding and foraging habitat within riparian areas. Projected increases in drought frequency and severity associated with climate change may further reduce riparian vegetation and available surface water, while increases in extreme storm and flooding events could periodically disrupt breeding populations (NDOW 2022).

Threats to Species

The primary threats to yellow-billed cuckoo in Clark County are the destruction, fragmentation, and modification of riparian habitat, and the application of pesticides. Very little suitable breeding habitat remains in Clark County due to extensive historic conversion for agricultural and urban development. The limited remaining habitat is further threatened by ongoing land use pressures and hydrological changes.

Pesticide use is a potential threat to the species. Significant accumulation of DDT and DDE in body tissues and eggs has been documented historically, with reports of direct adult mortality following DDT applications. While DDT is no longer used in the United States, it continues to be used in parts of Central and South America where the yellow-billed cuckoo winters, and population declines have been noted in areas with heavy pesticide use in agricultural lands bordering cuckoo habitat (Wiggins 2005). Prey scarcity linked to pesticide use may contribute to declines even in areas where suitable habitat remains.

The species' highly irruptive behavior and low site fidelity between years complicate conservation planning by making consistent population monitoring difficult and limiting the ability to assess actual breeding success across the landscape (NDOW 2022). Simulation modeling has demonstrated that populations of fewer than 10 pairs are highly vulnerable to stochastic extinction, suggesting that the small Clark County population is at elevated risk (Hughes 2015).

Conservation and Management

The western DPS of the yellow-billed cuckoo is protected under the Endangered Species Act as a threatened species and under the Migratory Bird Treaty Act of 1918, as amended. Critical habitat was designated for the western DPS; however, no critical habitat was designated within Nevada. As of this writing, a recovery plan has not been published.

The yellow-billed cuckoo is included in the Nevada Partners in Flight Bird Conservation Plan (Nevada Partners in Flight 1999). The Lower Colorado River Multi-Species Conservation Program includes the species among those for which it seeks to conserve habitat and reduce potential for additional listings (Lower Colorado River Multi-Species Conservation Program 2004). NDOW works with private landowners and federal agencies to manage grazing in areas occupied by yellow-billed cuckoos (NDOW 2003). Clark County Desert Conservation Program has purchased many cattle grazing privileges in southern Nevada, which has reduced understory impacts in historic breeding areas and made these sites more suitable for cuckoo nesting.

The Southern Nevada Water Authority owns 1,218 acres at the site formerly known as Warm Springs Ranch, which supports one of the two known confirmed breeding locations for yellow-billed cuckoo in Clark County. This property is managed as an ecological reserve, primarily to protect the endangered Moapa dace (*Moapa coriacea*) and its habitat (Curtis 2006). The Virgin River Conservation Partnership coordinates conservation and water development issues in the lower Virgin River Valley.

The table below summarizes modeled suitable habitat acreage in the MSHCP Amendment Plan Area (Simandle and Nussear 2025):

Yellow-billed cuckoo (*Coccyzus americanus*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	91,111	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	8,576	9.4%
Suitable Habitat in Lands Managed for Resource Conservation	8,981	9.9%
Suitable Habitat in the existing MSHCP Reserve System	587	0.6%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	125	0.1%

*Simandle and Nussear 2025

Clark County Survey Data

A series of surveys conducted from 2000 to 2006 detected yellow-billed cuckoos at Corn Creek and in Moapa Valley during most survey years; however, breeding was not confirmed at either location (Klinger and Furtek 2007). During this same survey period, the USGS detected cuckoos at the OWMA but was unable to confirm breeding, and cuckoos were not detected around Lake Mohave despite the existence of apparently suitable habitat (Johnson et al. 2007). The Nevada Breeding Bird Atlas reported confirmed breeding cuckoos on a private ranch on the upper Muddy River, and surveys conducted by the San Bernardino County Museum in 2001 confirmed breeding along the Virgin River (McKernan and Braden 2001; Floyd et al. 2007). The San Bernardino County Museum also detected cuckoos in the Mormon Mesa area of the Virgin River in 2006 and 2007 (Braden et al. 2007, 2008, 2009). Yellow-billed cuckoo has also been detected at Las Vegas Wash, though breeding was not confirmed in the early survey years.

Annual monitoring surveys for yellow-billed cuckoo are conducted on the MSHCP Riparian Reserve Units, which include the Muddy River, Mesquite, Bunkerville East, Bunkerville West, Riverside, Mormon Mesa, and Mormon Mesa South subunits. These surveys have resulted in sporadic detections between 2020 and 2025. In 2025, four cuckoo detections were recorded: one at the Riverside subunit, one at the Muddy River subunit (representing the first detection in the mesquite bosque adjacent to Parcel F), and two incidental detections at Mesquite West and Mormon Mesa. No possible or probable breeding territories were identified based on the single detections per subunit (SWCA 2025).

Annual yellow-billed cuckoo surveys are also conducted along Las Vegas Wash by the Southern Nevada Water Authority Las Vegas Wash Project Coordination Team. Surveys cover approximately 38 hectares of potentially suitable nesting habitat distributed across two sites: the Clark County Wetlands Park Nature Preserve and the Wash reach from Pabco Weir to Bostick Weir. A yellow-billed cuckoo was recorded for the first time in the 2022 to 2023 survey year (Year 18 of the study), representing one of five species newly detected at the site (GBBO 2024). In 2024, one yellow-billed cuckoo was detected in a native-dominated riparian patch upstream of Historic Lateral Weir, the same area supporting the study area's two nesting southwestern willow flycatcher territories that year. Habitat at that site is characterized by an overstory of Goodding's willow and cottonwood, with sandbar willow and tamarisk in the understory, and continues to mature following weir reconstruction in 2018. Although the 2024 detection constitutes a single-period observation insufficient to indicate breeding, the Las Vegas Wash study area has recorded probable breeding territories in 2017 and 2023 and possible breeding territories in 2019, 2020, and 2021. Cuckoo detections have been absent in only a few years since protocol surveys began in 2013, making the Wash among the most consistently productive yellow-billed cuckoo survey sites in Nevada.

With only approximately 5 to 10 yellow-billed cuckoos detected statewide each year, the Las Vegas Wash area accounts for a meaningful proportion of those statewide detections (van Dooremolen et al. 2025).

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Gilded Flicker (*Colaptes chrysoides*)

Photo Credit: Justin Streit, SWCA

Photo Credit: Justin Streit, SWCA

Species Overview

The gilded flicker (*Colaptes chrysoides*) is a medium-sized, heavy-bodied woodpecker and year-round resident of Sonoran and Mojave Desert habitats. The species is approximately 32 centimeters in length and weighs approximately 142 grams (NatureServe 2024). It was formerly treated as a subspecies of the northern flicker (*Colaptes auratus*) before being recognized as a distinct species in 1995 (AOU 1995). The gilded flicker differs from the northern flicker in several morphological features, including yellow rather than red webbing on the remiges and rectrices, a rusty-golden crown, narrower dorsal barring, paler dorsum, rounder breast patch, and a wider black tip on the underside of the tail (Kaufman 1979).

Gilded flickers are diurnal, non-migratory, and associated primarily with desert scrub and desert riparian habitats containing suitable nesting substrates. They are cavity nesters, excavating nest holes in large columnar cacti, Joshua trees (*Yucca brevifolia*), or tall riparian trees such as Fremont cottonwood (*Populus fremontii*). Nests are generally oriented northward and are unobstructed by other cactus arms (Zwartjes and Nordell 1998). Mean clutch size is 4.2 eggs; incubation by both sexes lasts 11 to 12 days, and young leave the nest 25 to 28 days after hatching (Moore et al. 2020). The species produces one brood per year (NDOW 2022). Breeding begins in February, and females typically reach sexual maturity the following season. Longevity records indicate a maximum known lifespan of 6 years and 4 months (Clapp et al. 1983).

Gilded flickers are omnivorous, feeding primarily on insects including ants, beetles, wasps, grasshoppers, and grubs, as well as fruits, berries, and seeds (Terres 1980; Moore et al. 2020). They forage on the

ground and have been observed probing ant colonies and catching insects in flight. The species has rarely been observed drinking and may obtain water by pecking into succulent vegetation (Kerpez and Smith 1990). The species also plays an important ecological role as a keystone cavity excavator: nest holes created by gilded flickers are subsequently used by numerous secondary cavity-nesting species including western screech-owl (*Megascops kennicottii*), pygmy-owl (*Glaucidium californicum*), ash-throated flycatcher (*Myiarchus cinerascens*), and European starling (*Sturnus vulgaris*) (Hardy and Morrison 2001; NatureServe 2024).

Range

The gilded flicker is endemic to the Sonoran Desert and has a restricted global range centered on the Arizona Upland subdivision of the Sonoran Desert. Rangewide, the species is found from extreme southern Nevada and the Colorado Desert of southeastern California south through much of western Arizona, Baja California Norte, Baja California Sur, Sonora, Sinaloa, and western Chihuahua, Mexico (Moore et al. 2020; Fink et al. 2023). It is notably absent from the northern portion of Baja California Norte (Patten et al. 2001; Moore et al. 2020). Using GBIF records from the past 20 years, range extent has been estimated at approximately 858,197 square kilometers (NatureServe 2024). Developed areas, even those with suitable habitat, are generally avoided by this species (Bagne and Finch 2012; Moore et al. 2020).

In Nevada, the gilded flicker is known from a small, confirmed population restricted to the extreme southern portion of the state in Clark County. The Nevada population is non-migratory and occurs primarily in Piute and Eldorado Valleys, with the core distribution centered on the area surrounding the southern Highland and Eldorado mountain ranges just north and northwest of Searchlight, Nevada (GBBO 2015; NDOW 2022). Historically, the species also occurred in riparian gallery forests along the lower Colorado River, but those populations have been extirpated for more than 40 years (NDOW 2022). Occasional records suggest the species may range farther north in the county on a limited basis (Floyd et al. 2007). Hybrids between the gilded flicker and the northern flicker have been documented in the nearby riparian corridor of the Virgin River in Washington County, Utah (Behle 1976).

Habitat Characteristics

The gilded flicker is a habitat specialist strongly associated with Sonoran Desert scrub, Mojave Desert scrub, and desert riparian habitats. Across most of its range, the species depends on tall columnar cacti, especially saguaro (*Carnegiea gigantea*) and Mexican giant cardón (*Pachycereus pringlei*), which provide substrates for nest cavity excavation (Moore et al. 2020; NatureServe 2024). In the core of its range, the species is closely associated with dense stands of these large cacti, and the loss of cavity-suitable large individuals is considered a significant conservation concern (Conver et al. 2017).

In Nevada, where saguaro cactus is absent, the gilded flicker is dependent on Joshua trees large enough to support cavity excavation. The species appears closely tied to dense stands of mature Joshua trees and will not breed where adequate nesting substrate is unavailable (NDOW 2022). Riparian areas supporting large cottonwood or ironwood (*Olneya tesota*) trees also provide potential nesting habitat, though such use has not been documented in Nevada (Corman and Wise-Gervais 2005). In addition to suitable nesting substrate, the gilded flicker requires open foraging habitat such as bare ground, lawns, or golf course fairways where it can forage on ground-dwelling invertebrates (Turner 2006). Within Clark County, high-suitability habitat occurs primarily in Mojave Desert Scrub and Blackbrush ecosystems, with

moderate habitat suitability extending into Mesquite-Acacia and Desert Riparian ecosystems (Nussear and Simandle 2020).

The species is not tolerant of significant human disturbance. Although it can occasionally occupy suburban areas with large trees, parks, and golf courses, it generally avoids developed areas even where suitable vegetation is retained (Bagne and Finch 2012; Corman and Wise-Gervais 2005; Moore et al. 2020).

Habitat Suitability Model

Nussear and Simandle (2020) developed species distribution models for the gilded flicker in Clark County using an ensemble modeling approach that incorporated three algorithms: GAMs, Maximum Entropy (MaxEnt), and RF. Model performance was high across all algorithms, with the Ensemble model achieving AUC = 0.95, BI = 0.94, and TSS = 0.84. The locality dataset comprised 223 occurrence records, which were spatially thinned to 127 records for model training and testing.

The top environmental variables contributing to model predictions across algorithms included Average Spring Maximum Temperature, the coefficient of variation of Average Winter Precipitation (CV Winter Precipitation), NDVI Maximum, and topographic slope. The GAM and MaxEnt models consistently predicted higher habitat suitability in areas with lower spring temperatures and higher variability in winter precipitation, while the RF model emphasized precipitation variability and NDVI Maximum as the strongest predictors. Slope had a negative association with predicted habitat quality across all algorithms.

Nussear et al. (2024) updated the Clark County habitat suitability models using an expanded set of algorithms including GAM, MaxEnt, RF, and Gradient Boosting Models. Updated models incorporated vegetation layer data. Model performance remained high across all algorithms, with the Ensemble model achieving AUC values near or above 0.96 and TSS values at or above 0.81. In the updated models, CV of Winter Precipitation remained a dominant predictor, with high importance in the GAM, RF, and GBM algorithms. Distance to cliffs and Winter Precipitation also had high contributions in several algorithms. Vegetation was a contributing variable in models that included that layer. The vegetation type most strongly associated with gilded flicker localities was Western North American Cool Semi-Desert Scrub and Grassland, and North American Warm Desert Scrub and Grassland.

Modeled habitat for the gilded flicker in Clark County is concentrated in the southernmost portions of the county, consistent with the species' known occurrence near the Highland and Eldorado mountain ranges. The models also predicted bands of suitable habitat along the southern uplands surrounding the Spring Range near Trout Canyon and the Red Rock area, and along the southern margins of the Sheep Range, though no confirmed occurrence records have been documented in these northern areas. A large area of predicted habitat also occurs east of the Colorado River near Laughlin, Arizona. The predicted habitat is shown in Figure 8.

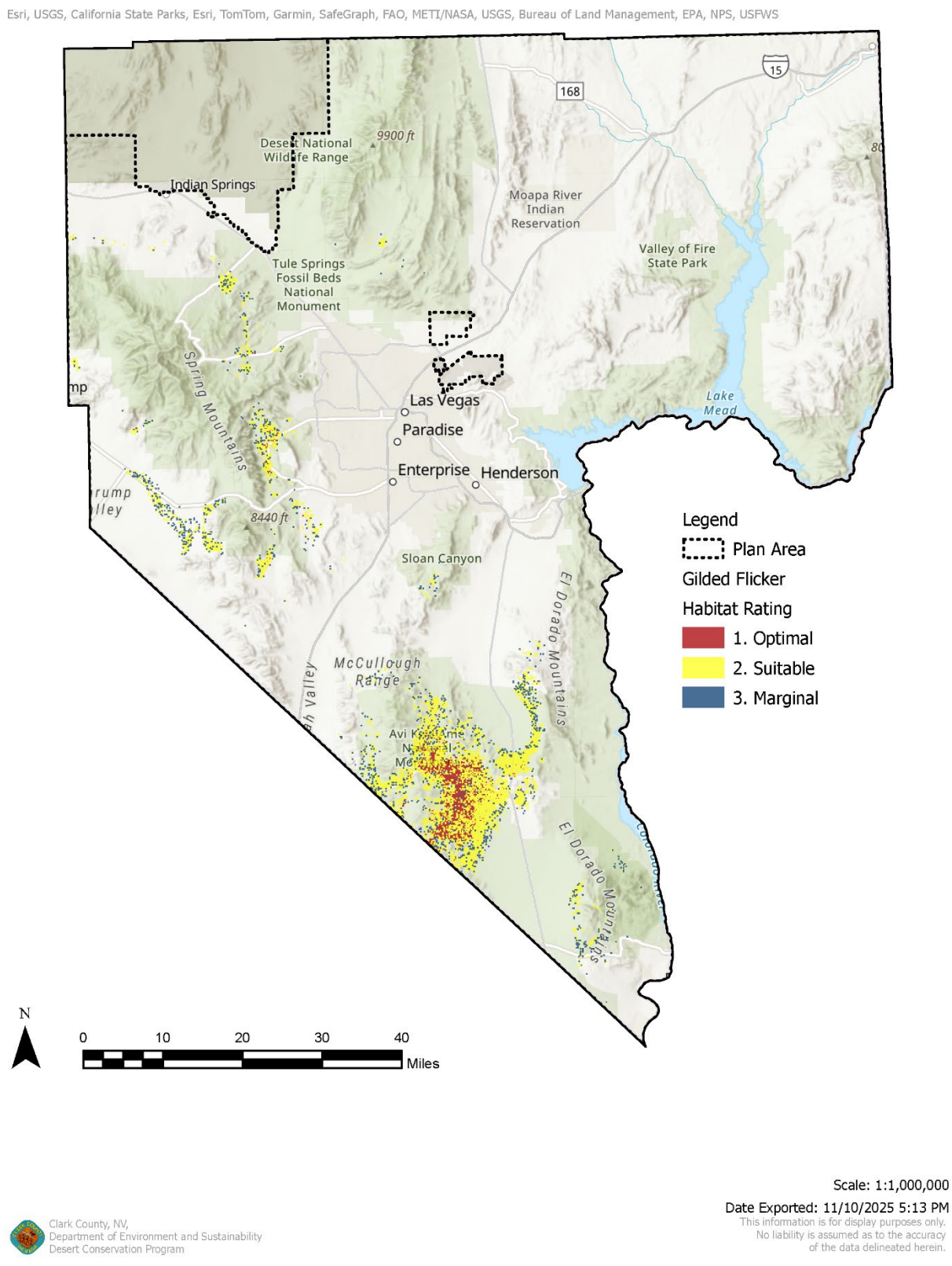

Figure 8. Habitat Suitability Model for Gilded Flicker (*Colaptes chrysoides*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

The regulatory and conservation status of the gilded flicker is summarized in the table below.

Agency/Organization	Status
MSHCP (2000)	No Status
U.S. Fish and Wildlife Service Endangered Species Act	No Status
Migratory Bird Treaty Act	Protected
U.S. Bureau of Land Management (Nevada)	No Status
U.S. Forest Service (Region 4)	No Status
State of Nevada	No Status
State of Arizona	Species of Greatest Conservation Need
State of California	State Endangered
State of Utah	None
NV Division of Natural Heritage	At Risk
NV State Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Presumed Stable
NatureServe Global and NV State Rank	G4 S1
IUCN Red List	Least Concern
CITES	No Status

The gilded flicker has no listing status under the federal Endangered Species Act at the national level. However, the taxon *Colaptes auratus chrysoides* was petitioned for listing in California by the California Department of Fish and Game in 1987, citing loss of saguaro and other habitat needs, as well as hybridization with northern flickers in Joshua tree woodlands near Cima Dome, San Bernardino County (NDOW 2022). California currently lists the species as State Endangered. The species is protected at the federal level under the Migratory Bird Treaty Act.

NatureServe (2024) assessed the global conservation status of the gilded flicker as G4 (Apparently Secure), with the global status last reviewed on June 10, 2024. This assessment reflects the species' limited but relatively stable range, recent short-term population increases, and projected resilience to climate change, though it also notes the long-term historical population decline and ongoing threats. The state rank in Nevada is S1 (Critically Imperiled), reflecting the species' extremely restricted and small population within the state. Arizona is ranked S3 (Vulnerable) and California S2 (Imperiled) (NatureServe 2024). The 2022 Nevada State Wildlife Action Plan recorded the Nevada Natural Heritage rank as G5S1 (NDOW 2022), reflecting the prior global ranking before NatureServe's June 2024 downlisting of the global rank from G5 to G4.

The IUCN Red List (BirdLife International 2012) classifies the gilded flicker as Least Concern based on its large population size, large range, and rate of population decline that does not approach the threshold for a more threatened category. The species has no CITES listing.

Population Trends

Rangewide Breeding Bird Survey data indicate a long-term population decline of approximately 54 to 58 percent from 1970 to 2014 (Rosenberg et al. 2016). Partners in Flight placed the species on its Yellow Watch List as a vulnerable species requiring population recovery efforts in North America (Rosenberg et al. 2016). More recent trend data indicate some recovery: eBird Status and Trends data show a 13.5 percent increase in the rangewide population from 2011 to 2021 (Fink et al. 2023). The global population is estimated at 192,000 to 240,000 individuals in the United States (Rosenberg et al. 2016, 2019); the size of the population in Mexico is unknown. Despite the recent short-term increase, NatureServe (2024) characterizes the long-term trend as a decline of 50 to 70 percent, consistent with Partners in Flight estimates.

In Nevada, no formal trend data exist for the gilded flicker population. Rangewide Breeding Bird Survey results indicate nonsignificant declines across the Sonoran and Mojave deserts (Sauer et al. 2020). Nevada supports less than 2 percent of the overall population, meaning rangewide trends may not be representative of conditions within the state (NDOW 2022). The Nevada population is considered critically imperiled (S1) given its restricted range and small size, and population monitoring within Clark County remains a priority research need.

Habitat Level Threats

The primary habitat-level threat to the gilded flicker across its range is the loss and degradation of Sonoran Desert and Mojave Desert vegetation communities that provide nesting substrate. In Arizona and Sonora, the progressive loss of large-diameter saguaro cacti capable of supporting nest cavity excavation is a significant concern; while saguaro populations are not expected to decline dramatically under climate change projections, the loss of the largest size classes represents a functional reduction in nesting habitat availability (Conver et al. 2017; NatureServe 2024).

In Nevada, the analogous threat is loss or degradation of Joshua tree woodlands. Climate change projections indicate that conditions suitable for Joshua tree recruitment will shift northward and to higher elevations, potentially causing significant contractions of Joshua tree habitat in southern portions of Clark County where the gilded flicker currently occurs (NDOW 2022). Loss of mature Joshua trees from drought, temperature stress, or mechanical disturbance directly reduces the availability of cavity nesting substrate.

Invasive annual grasses, particularly buffel grass (*Pennisetum ciliare*), degrade habitat quality by reducing ant abundance (an important prey item), and by substantially increasing the frequency and severity of wildfire in desert ecosystems not adapted to fire (Bagne and Finch 2012; Wilder et al. 2021; Li et al. 2023). Wildfire destroys Joshua trees, cottonwoods, and other nesting trees and can cause large-scale, persistent habitat loss. Large-scale renewable energy development (solar and wind) removes desert scrub and Joshua tree woodland habitat and may alter local microclimatic conditions through heat island effects adjacent to utility-scale solar facilities (Nussear and Simandle 2020). Urban and suburban development, military training, utility and transportation infrastructure, and mining activities in the Searchlight district represent additional sources of direct habitat loss within Clark County.

Threats to Species

Threats to the continued survival of the gilded flicker in Clark County and within Nevada include any disturbance that reduces the availability of large nesting trees and cacti. The species' dependence on mature Joshua trees large enough for cavity excavation creates a narrow ecological constraint, as Joshua trees require decades to attain suitable size. Loss of mature individuals through fire, development, or climate-related stress thus has long-term consequences for nesting habitat availability.

The restricted range of the Nevada population renders it particularly sensitive to localized threats. The limited number of confirmed breeding locations means that any large-scale disturbance event, such as a wildfire or major development project, could disproportionately affect a substantial portion of the state population. Wind turbines are known to cause direct mortality in a variety of bird species and represent an additional threat in areas where renewable energy development overlaps with predicted habitat (Nussear and Simandle 2020; NDOW 2022). The 2022 Nevada State Wildlife Action Plan (NDOW 2022) categorizes direct threats to the gilded flicker in Nevada by severity: fire and fire suppression (IUCN threat category 7.1) is rated a high threat, reflecting the potential for increased fire frequency and intensity to significantly impact this range-restricted species in non-fire-adapted habitat; renewable energy development (category 3.3) is rated a medium threat, given the species' limited distribution in Nevada and vulnerability to large-scale wind and solar development within and adjacent to suitable habitat; and housing and urban development in mid-elevation areas with Joshua trees (category 1.1) is rated a low threat.

Competition for nest cavities with European starlings (*Sturnus vulgaris*), a non-native species that aggressively usurps cavities, has been identified as a potential threat to reproductive success, particularly in areas where starling populations are established (LCR MSCP 2004). While the gilded flicker is considered a keystone cavity excavator whose nest sites benefit many secondary cavity users, population decline could have broader community-level effects by reducing the availability of fresh cavities for dependent species (Moore et al. 2020).

Conservation and Management

The gilded flicker is afforded federal protection under the Migratory Bird Treaty Act and is listed as a Species of Conservation Priority by the Nevada State Wildlife Action Plan (NDOW 2022). The State Wildlife Action Plan designates the species as a priority based on its restricted range in Nevada and declining population trends rangewide. Recommended conservation actions under the State Wildlife Action Plan include protecting known habitat from development and heavy recreational use, aggressively suppressing wildfire in occupied habitat, searching for additional breeding locations including within the Wee Thump Joshua Tree Wilderness Area, and conducting research to determine habitat patch size requirements, seasonal movements, and population size (GBBO 2010; NDOW 2022).

The Nevada Comprehensive Bird Conservation Plan designates the gilded flicker as a Conservation Priority species, citing population declines, significant threats, dependence on restricted or threatened habitats, and small population size (GBBO 2010). The gilded flicker is also a covered species under the Lower Colorado River Multi-Species Conservation Plan (LCR MSCP 2004), which prescribes conservation measures including creation and adaptive management of 4,050 acres of cottonwood-willow habitat, installation of artificial snags to provide nest sites, avoidance and minimization of impacts from covered activities during the breeding season, and research to identify threats and habitat requirements.

Gilded flicker (*Colaptes chrysoides*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	144,339	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	1,742	1.2%
Suitable Habitat in Lands Managed for Resource Conservation	120,557	83.5%
Suitable Habitat in the existing MSHCP Reserve System	0	0.0%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	6,466	4.5%

**Nussear et al. 2024*

Clark County Survey Data

Prior to targeted survey efforts, occurrence records for gilded flicker in Clark County were limited. The Great Basin Bird Observatory Breeding Bird Atlas (Floyd et al. 2007) recorded approximately 20 pairs in the foothills of the Eldorado Range. Subsequent Great Basin Bird Observatory surveys (2015) documented 10 sightings in the southern Highland and Eldorado mountain ranges over a two-decade period, including a co-occurring male and female on the same day, suggesting a resident breeding population just north and northwest of Searchlight. An adult male and female were also observed together south of the Highland Range near Walking Box Ranch, representing an additional probable breeding location (GBBO 2015).

SWCA Environmental Consultants conducted focused surveys for gilded flicker in Clark County during 2021 (SWCA 2021). Six gilded flicker detections were recorded across three sites: McCullough Mountain, the Highland Range, and Bird Springs. Four of the six detections occurred at McCullough Mountain, which supported the largest and densest Joshua trees of any site surveyed. A pair was detected at the Highland Range site, representing the highest level of breeding evidence recorded during those surveys. A single detection at the Bird Springs site occurred outside of predicted habitat, indicating that the species' range in Clark County may extend beyond currently modeled boundaries.

In 2022, SWCA conducted more extensive focused surveys at ten sites selected for gilded flicker within Clark County (SWCA 2022). A total of 21 area-search detections and 23 incidental detections were recorded, for a combined total of 44 confirmed detections. Twenty-five of these detections were more than 2.5 kilometers from existing detection locations and were clustered near the Lucy Gray, Crescent Peak, and Middle Piute Valley sites, substantially expanding the documented range within the county. Confirmed breeding evidence was documented at two sites: at the New York Mountains site, an active nest with young was observed and an adult was seen carrying food; at the Crescent Peak site, an adult was observed visiting a probable nest cavity. An old nest cavity of a size suitable for a flicker was also found in a Joshua tree just outside the McCullough Spring subplot, suggesting former occupancy of that site. Elevations of detections ranged from approximately 3,425 feet to 4,694 feet above mean sea level.

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Southwestern Willow Flycatcher (*Empidonax traillii extimus*)

Photo Credit: Brian Small Photography

Photo Credit: Sarah Nichols, SWCA

Species Overview

The southwestern willow flycatcher is a small neotropical migrant and generalist insectivore, approximately 15 centimeters in length and weighing approximately 11 grams (NatureServe 2026). It is grayish-green dorsally with a white throat and olive-colored breast, becoming yellowish on the belly, with white wing bars and a dark bill with a lighter lower mandible (Nussear and Simandle 2020). Like other members of the genus *Empidonax*, willow flycatchers are notoriously difficult to distinguish visually from closely related species and subspecies. The species is most easily identified by its distinctive "fitz-bew" song (NDOW 2022).

It breeds primarily in riparian woodlands composed of cottonwood (*Populus* spp.) and willow (*Salix* spp.) gallery forests but also uses areas dominated by introduced salt cedar (*Tamarix* spp.) (Durst et al. 2008). Nesting typically occurs from early June through the end of July, with peak activity in mid-June. Clutch size is usually 3 to 4 eggs; incubation lasts 12 to 15 days and is performed by the female; young fledge approximately 12 to 15 days after hatching (NatureServe 2026). The species typically raises one brood per year and has a maximum known lifespan of 11 years (NDOW 2022). The species forages primarily by aerial hawking, catching insects in flight, and occasionally gleans insects from foliage or supplements its diet with berries (NatureServe 2026, NDOW 2022).

The southwestern willow flycatcher (*Empidonax traillii extimus*) is one of four recognized subspecies of the willow flycatcher (*E. traillii*), along with *E. t. brewsteri*, *E. t. adastus*, and *E. t. traillii* (Hubbard 1987, Unitt 1987), though Browning (1993) posits a fifth subspecies (*E. t. campestris*) in the central and Midwestern United States. Molecular genetic studies by Paxton (2000) concluded that *E. t. extimus* is genetically distinct from the other willow flycatcher subspecies, and most authors have accepted its taxonomic status (Unitt 1987, USFWS 1995). Some contention over the genetic justification for recognizing the southwestern willow flycatcher as a distinct subspecies continues in the literature (Paxton et al. 2008, Zink 2015, Theimer et al. 2016).

Critical habitat is designated for the southwestern willow flycatcher on the Virgin and Muddy Rivers in Clark County (USFWS 2013).

Range

The southwestern willow flycatcher breeds in the southern portions of California, Nevada, Arizona, Utah, Colorado, New Mexico, west Texas, and extreme northwestern Mexico (USFWS 1995, 2002). The majority of the subspecies' known breeding territories (approximately 75 percent) are concentrated in New Mexico and Arizona (Durst et al. 2008, NatureServe 2026). The northern distributional limit of this subspecies cannot be precisely defined (USFWS 2013). Elevational range extends from near sea level to over 2,600 meters, though the majority of territories are below 1,600 meters (Durst et al. 2008). The subspecies winters from central Mexico south to northwestern Colombia (NatureServe 2026).

Three of the four subspecies of willow flycatcher (*E. t. extimus*, *E. t. adastus*, and *E. t. brewsteri*) are known to breed in Nevada, but only the southwestern willow flycatcher breeds in Clark County (GBBO 2010). In Clark County, the southwestern willow flycatcher is known to breed in and migrate through riparian habitats along the Colorado River, the Virgin River above Lake Mead, the Muddy River, Las Vegas Wash, and the Meadow Valley Wash (GBBO 2010, Nussear and Simandle 2020).

Habitat Characteristics

The southwestern willow flycatcher occupies riparian and wetland thickets, generally composed of willow (*Salix* spp.), tamarisk (*Tamarix* spp.), or both, and sometimes including boxelder, Russian olive (*Eleagnus angustifolia*), cottonwood (*Populus* spp.), or other native or exotic riparian species (USFWS 2013, Nussear and Simandle 2020). Habitat patches as small as 0.5 hectares can support one or two nesting pairs (USFWS 1995). Nests are typically placed in trees where plant growth is densest, where shrubs have vegetation near ground level, and where there is a low-density canopy (USFWS 2013). Breeding territories average approximately 1.5 acres, and densities may reach 9 to 14 pairs per 100 acres (NatureServe 2026).

Habitat patches comprising mostly native vegetation account for fewer than half of the known flycatcher territories rangewide (Durst et al. 2008). While salt cedar appears to be less preferred than native riparian vegetation for breeding, there appears to be no effect on the nutritional condition of birds breeding in salt cedar-dominated habitat (Nussear and Simandle 2020). Native riparian plant communities are considered to have greater recovery value for the subspecies, but currently occupied and suitable tamarisk habitat should be maintained as a management consideration (USFWS 2002).

During migration, the species may use a wider variety of riparian habitats, including those dominated by native or exotic plant species or mixtures of both, that would be unsuitable for nesting due to insufficient vegetation structure (USFWS 2013). In Clark County, preferred breeding habitat includes dense riparian vegetation near watercourses or wetlands; preferred plant species include willow, cottonwood, tamarisk, and Russian olive (Nussear and Simandle 2020).

Habitat Suitability Model

Simandle and Nussear (2025) developed updated species distribution models for the southwestern willow flycatcher within and around Clark County using an ensemble modeling approach. Two model configurations were developed: one using Clark County vegetation divisions without a buffered area, and one without vegetation divisions but with a buffered area extending beyond county boundaries. Both

ensemble models demonstrated robust performance, with high discriminatory ability (AUC > 0.98) and high accuracy at selected thresholds (TSS > 0.88) (Simandle and Nussear 2025).

Key environmental variables influencing habitat suitability varied somewhat between model configurations but consistently included soil properties (particularly coarse fragment content and a sand/silt/clay principal component), the coefficient of variation of winter precipitation, the silica index, and minimum temperature variability. In general, habitat suitability was highest in areas with low coarse fragment content, fine-textured soils, higher variability in winter precipitation, and lower variability in minimum temperatures (Simandle and Nussear 2025). These variables collectively reflect the fine-grained, hydrologically active soils and relatively mild thermal conditions associated with productive riparian corridors.

Highly suitable habitat for the southwestern willow flycatcher is limited in distribution across Clark County (Figure 9). The primary areas of highly suitable habitat are predicted near the Meadow Valley Wash, the Muddy River, and the Virgin River. Additional patches of highly suitable habitat are found in northwest Las Vegas Valley, Indian Springs Valley, near Pahrump and Sandy Valley, and along the Colorado River in areas near Bullhead City and the Mohave Valley (Simandle and Nussear 2025).

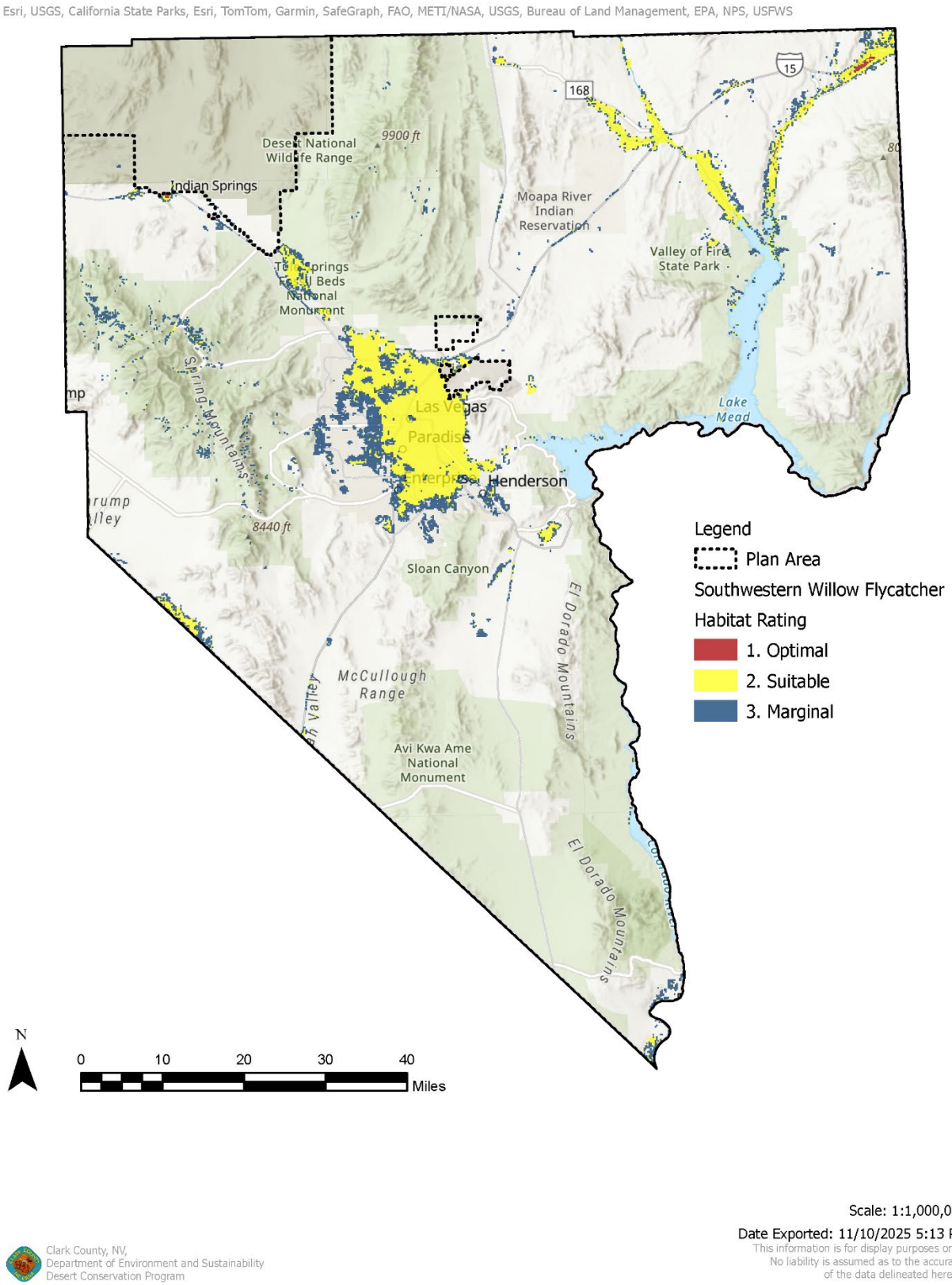

Figure 9. Habitat suitability model for the southwestern willow flycatcher (*Empidonax traillii extimus*) in Clark County, Nevada (Simandle and Nussear 2025).

Species Status

Agency/Organization	Status
MSHCP (2000)	Covered
U.S. Fish and Wildlife Service Endangered Species Act	Endangered
Migratory Bird Treaty Act	Protected
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	Endangered
State of Nevada	Endangered
State of Arizona	Species of Greatest Conservation Need
State of California	Endangered
State of Utah	Species of Greatest Conservation Need
NV Division of Natural Heritage	At Risk
NV State Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Presumed Stable
NatureServe Global and NV State Rank	G5T2 S1B
IUCN Red List (v 2025-2)	Not Listed
CITES	Not Listed

The southwestern willow flycatcher was listed as a federally endangered subspecies under the Endangered Species Act on February 27, 1995 (USFWS 1995), three years after conservation organizations originally petitioned for listing. In 2015, the Pacific Legal Foundation petitioned USFWS to delist the subspecies; in 2016, USFWS found that delisting may be warranted based on information related to taxonomic status, but determined that a full status review was needed (Nussear and Simandle 2020). In 2018, USFWS found that a petition to remove the subspecies from the Federal List of Endangered and Threatened Wildlife was not warranted (NatureServe 2026). In 2024, USFWS initiated a new 5-year status review under the Endangered Species Act (NatureServe 2026). The southwestern willow flycatcher is also protected under the Migratory Bird Treaty Act (Nussear and Simandle 2020).

NatureServe (2026) assigns the southwestern willow flycatcher a global conservation status rank of G5T2 (imperiled subspecies of a secure species), reflecting a long-term rangewide decline estimated at 50 to 90 percent driven primarily by riparian habitat loss and degradation. The subspecies has disappeared from 142 of 288 historical breeding sites since the early 1990s, and only 6 of 173 known sites support more than 50 territories (NatureServe 2026). The national rank is N2B (imperiled as a breeding subspecies in the United States), and the Nevada state rank is S1B (critically imperiled breeding subspecies). The subspecies is not listed by the IUCN Red List or CITES.

Population Trends

Populations of the southwestern willow flycatcher have declined an estimated 75 to 90 percent over the last century, driven primarily by destruction and degradation of cottonwood-willow and structurally similar riparian habitats (Nussear and Simandle 2020). NatureServe (2026) characterizes the long-term trend as a decline of 50 to 90 percent. The subspecies has disappeared from 142 of 288 known breeding sites since the early 1990s, and most of the sites from which flycatchers have disappeared were represented by only 1 to 2 territories (NatureServe 2026).

The short-term trend is less certain. Intensive surveys over the past decade have increased the number of known breeding pairs, making it difficult to establish a rangewide short-term trend; however, the area of occupancy and abundance are believed to have been relatively stable or slowly declining over the past 10 years (NatureServe 2026). As of 2007, approximately 1,300 breeding territories were known throughout the range, with Arizona, New Mexico, and California accounting for the greatest number of sites and territories. Nevada, Colorado, and Utah combined account for approximately 12 percent of known territories (Nussear and Simandle 2020). Recent survey efforts have declined overall, making population estimates less precise; nonetheless, the subspecies' population appears to be stable to declining (USFWS 2014).

Within Clark County, there are 19 known breeding sites and up to 97 territories (Swett 1999, USFWS 2014). The Lower Colorado River Recovery Units remain approximately 75 percent short of numerical reclassification goals under the USFWS Recovery Plan, and territory numbers have changed little within those units since completion of the recovery plan in 2002 (USFWS 2014). Since 2020, annual monitoring conducted by the Clark County Desert Conservation Program across its Riparian Reserve Units has documented 18 to 28 flycatchers annually and modest but meaningful improvements in productivity (SWCA 2025).

Habitat Level Threats

Riparian ecosystems supporting the southwestern willow flycatcher have declined substantially throughout the American Southwest due to a combination of interacting stressors. Loss and degradation of cottonwood-willow and structurally similar riparian habitats are the primary drivers of subspecies decline (NatureServe 2026). Specific causes of habitat loss and change include water impoundment, water diversion and groundwater pumping, stream channelization and bank stabilization, riparian vegetation control, livestock grazing, off-road vehicle and other recreational uses, increased fire frequency, urban and agricultural development, and hydrological changes resulting from these and other land uses (NatureServe 2026, Nussear and Simandle 2020).

Tamarisk (*Tamarix* spp.) invasion has replaced native riparian vegetation in many areas across the subspecies' range, with varying effects on flycatcher populations. Native riparian plant communities are considered to have greater recovery value, but currently occupied tamarisk habitat should be maintained as replacement habitat is developed (USFWS 2002). The exotic tamarisk leaf beetle (a biocontrol agent released as part of a USDA program that was terminated in 2010) continues to damage tamarisk stands throughout portions of the subspecies' range, including areas of Nevada, Arizona, and New Mexico, with uncertain but potentially significant implications for subspecies that currently breed in tamarisk-dominated habitat (NatureServe 2026).

Wintering habitat limitations are poorly understood, but the amount of lowland wet habitat within the wintering range has declined substantially over the past century (NatureServe 2026). Ongoing and

projected climate change is expected to reduce the rangewide availability of suitable nesting habitat for willow flycatchers by further reducing streamflow and increasing aridity in riparian corridors (NatureServe 2026, NDOW 2022).

In Clark County, threats to southwestern willow flycatcher habitat include removing, thinning, or destroying riparian vegetation; reductions in water flow; interruptions in natural hydrological events; physical modifications to streams; modification of native plant communities by invasion of exotic species and livestock grazing; and direct removal of riparian vegetation through water diversions and groundwater pumping (USFWS 2002, Nussear and Simandle 2020). Fire is also a threat to riparian ecosystems, as many native riparian plants are not fire-adapted and recover poorly following fire events (USFWS 2002). Agricultural development can impact riparian ecosystems through direct clearing of vegetation, floodplain re-engineering, and use of herbicides and pesticides (Nussear and Simandle 2020). Pesticide use in agricultural areas adjacent to nesting grounds, and on migrating and wintering grounds, is an additional concern for the subspecies (NatureServe 2026). Incremental habitat loss from urban and suburban development, particularly within and adjacent to riparian corridors in the Las Vegas Valley and other portions of Clark County, also represents an ongoing threat to the subspecies and its habitat.

Threats to Species

The southwestern willow flycatcher faces multiple threats to its continued survival, particularly within the fragmented riparian landscapes of Clark County. Brood parasitism by the brown-headed cowbird (*Molothrus ater*) is a significant threat; 20 to 30 percent of nests rangewide are parasitized, and parasitism negatively affects reproductive performance by reducing the number of flycatcher young fledged per female per year (Nussear and Simandle 2020). Cowbirds are increasingly abundant in floodplains and areas of increased grazing, and modified habitats with increased edge effects are associated with elevated nest parasitism rates (Nussear and Simandle 2020). Prior to cowbird control efforts in Clark County, parasitism rates at monitored sites ranged from 33 to 67 percent, with an average of 50 percent (SWCA 2025).

The subspecies exists in small, fragmented populations throughout its range, with only 6 populations supporting more than 50 nesting pairs (NatureServe 2026). The persistence of smaller populations is dependent on immigration from nearby populations, and their isolated nature increases the risk of local extirpation (USFWS 2002). Single severe weather events or other stochastic factors can reduce a small population below a recovery threshold (USFWS 2002). Sex biases have also been reported in small declining populations, with varying implications for management (Durst et al. 2008).

Conservation and Management

The USFWS Southwestern Willow Flycatcher Recovery Team Technical Subgroup prepared a final recovery plan for the subspecies in 2002 (USFWS 2002). The Recovery Plan's main objectives are to increase and improve occupied, suitable, and potential breeding habitat; increase metapopulation stability; improve demographic parameters; minimize threats to wintering and migration habitat; survey and monitor; conduct research; provide public education and outreach; and assure implementation of laws, policies, and agreements that benefit the subspecies (USFWS 2002).

In 2013, USFWS designated approximately 1,975 stream kilometers (84,569 hectares) as critical habitat for the southwestern willow flycatcher in California, Nevada, Arizona, New Mexico, Utah, Colorado, and Texas (USFWS 2013). Within Clark County, critical habitat includes a 48.4 kilometer segment of the Virgin River from the Arizona border to Colorado River Mile 280 at the upper end of Lake Mead. A 3.1

kilometer segment of the Muddy River within the Overton State Wildlife Area was identified as essential to flycatcher conservation but was excluded from the critical habitat designation because the State of Nevada already manages riparian habitat within the wildlife area for the subspecies (Nussear and Simandle 2020).

The Nevada State Wildlife Action Plan (NDOW 2022) identifies the southwestern willow flycatcher as a Species of Greatest Conservation Need and recommends protecting nesting habitat from disturbances, degradation, and conversion; restoring lost or degraded riparian habitat to a willow-dominated condition; phasing restoration projects to avoid removal of large amounts of tamarisk before suitable replacement habitat is established; and continuing intensive monitoring efforts to track population trends.

The Nevada Comprehensive Bird Conservation Plan (GBBO 2010) concurs with these recommendations and additionally recommends developing strategies to address potential loss of tamarisk breeding habitat to biocontrol agents, and developing comprehensive fire management strategies to protect important breeding habitat.

The southwestern willow flycatcher is also covered under the Lower Colorado River Multi-Species Conservation Program, which aims to conserve habitat of threatened and endangered species and reduce additional listings, while accommodating existing water diversions and power production (Nussear and Simandle 2020). It is additionally addressed in the Spring Mountain Conservation Agreement between various agencies to provide long-term protection for rare and sensitive flora and fauna of the Spring Mountains National Recreation Area (Nussear and Simandle 2020).

The conceptual management plan for the OWMA includes specific objectives for the southwestern willow flycatcher, including monitoring population changes, protecting and restoring habitat, maintaining wet soils within breeding sites from May 1 through August 1, removing tamarisk and replacing with cottonwood and willow plantings, and coordinating with conservation partners (Nussear and Simandle 2020).

The table below summarizes the distribution of suitable southwestern willow flycatcher habitat within the MSHCP Amendment Plan Area and associated management zones (Simandle and Nussear 2025).

Southwestern willow flycatcher (*Empidonax traillii extimus*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	194,330	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	28,677	14.8%
Suitable Habitat in Lands Managed for Resource Conservation	73,829	38.0%
Suitable Habitat in the existing MSHCP Reserve System	1,968	1.0%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	653	0.3%

*Simandle and Nussear 2025

Clark County Survey Data

Survey efforts for the southwestern willow flycatcher in Clark County have documented the subspecies' use of riparian areas along the Virgin River, Muddy River, Las Vegas Wash, and other drainages. There are

19 known breeding sites and up to 97 territories documented in Clark County (Swett 1999, USFWS 2014). The Lower Colorado River Recovery Units, which encompass Clark County sites, remain approximately 75 percent short of their numerical reclassification goals under the Recovery Plan, and territory numbers in these units have changed little since 2002 (USFWS 2014).

Since 2017, the Clark County Desert Conservation Program has conducted annual monitoring for the southwestern willow flycatcher across all Riparian Reserve Units it manages, including the Mesquite West, Bunkerville, Riverside, and Mormon Mesa reserves. Annual detections have ranged from 18 to 28 flycatchers, targeting both nestlings and adult birds. Annual fledgling success over the survey period has ranged from 1 to 26 birds. In 2025, 26 adult willow flycatchers were detected, including 23 at monitored sites and three at survey-only or point-count locations. Eight nesting pairs were documented at Mesquite West, with 10 confirmed nesting attempts producing 8 fledglings (SWCA 2025).

In 2020, the Clark County Desert Conservation Program initiated a brown-headed cowbird control program to reduce brood parasitism of the southwestern willow flycatcher. Prior to cowbird control, parasitism rates at monitored sites ranged from 33 to 67 percent, with an average of 50 percent. Parasitism rates declined substantially following initiation of the control program, reaching an all-time low of 8 percent in 2023 and remaining low at 9 percent in 2024 and 13 percent in 2025 (SWCA 2025). Over the five-year combined-method cowbird control period from 2021 to 2025, the average parasitism rate was 20 percent, compared to 55 percent in the five years prior to control. Nest success averaged 53 percent during the control period versus 16 percent before. Prior to control, female southwestern willow flycatchers experienced an average annual fecundity of less than 1.0 young per female; following implementation of cowbird control, fecundity averaged 1.61 young per female from 2021 to 2025, with statistical tests confirming that nest success, productivity, and fecundity were all significantly higher during the cowbird control period (SWCA 2025).

Annual southwestern willow flycatcher surveys have been conducted along the Las Vegas Wash since 1998, with the Southern Nevada Water Authority as the lead agency under the Las Vegas Wash Coordination Committee (van Dooremolen et al. 2025). In 2024, field personnel identified three resident southwestern willow flycatchers comprising two territories, both located in passively established, native-dominated riparian habitat above Historic Lateral Weir on the Wash. One pair nested successfully, producing one confirmed fledgling, representing only the second confirmed fledgling in 27 years of surveys at the site. The female laid a second clutch, but that nest failed. A second territory was established by a lone male but was abandoned by early July. No brood parasitism or depredation was observed in 2024. Of the 143 adult willow flycatchers detected over 27 years of surveys along the Las Vegas Wash, just 12 have been residents establishing breeding territories; 10 of those have occurred in the past four years, reflecting the maturation of native riparian habitat above Historic Lateral Weir following its reconstruction in 2018 (van Dooremolen et al. 2025).

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Loggerhead Shrike (*Lanius ludovicianus*)

Photo Credit: Brian Small Photography

Photo Credit: Justin Streit, SWCA

Species Overview

The loggerhead shrike (*Lanius ludovicianus*) is a medium-sized songbird and one of only two members of the shrike family (Laniidae) native to North America. It is also the only raptorial songbird, uniquely equipped with a hooked, notched beak resembling that of the American kestrel (*Falco sparverius*), which it uses to dispatch and process prey. The species is readily identified by its gray back and crown, white underparts, black mask across the eyes, and bold black-and-white wing and tail markings. The loggerhead shrike has a large head relative to its body, giving it a top-heavy appearance that distinguishes it from other small passerines.

Loggerhead shrikes are known by the colloquial name "butcherbird" for their habit of impaling prey on sharp objects such as yucca leaves, mesquite spines, creosote bush twigs, and barbed wire fences. Because the species lacks the heavy talons of true raptors to hold prey while feeding, it uses these impaling stations to anchor and dismember prey items (Dawson 1923). Prey includes large insects such as grasshoppers, beetles, and crickets; scorpions and centipedes; small lizards and snakes; small birds; and small mammals including house finches, horned larks, meadow mice, and kangaroo rats (Dawson 1923, Bent 1965, Kridelbaugh 1983, Yosef 1996). Vertebrate prey are killed by biting the neck and disarticulating cervical vertebrae (Pruitt 2000). Like raptors and some corvids, loggerhead shrikes regurgitate indigestible material including exoskeletons and bones as pellets (Dawson 1923).

Loggerhead shrikes inhabit open to semi-open landscapes where elevated perches allow them to scan for prey. They are territorial year-round and defend separate territories in breeding and nonbreeding seasons. Nesting may begin as early as mid-March in southern Nevada, with clutches of approximately 5 to 7 eggs that are pale bluish gray to dull grayish-white with yellow-brown to gray-brown blotching (Dawson 1923). Incubation lasts approximately 16 to 18 days, and altricial young fledge within 17 to 20 days (Yosef 1996, NDOW 2022). The species may produce two clutches per season. Territory sizes of

loggerhead shrikes throughout North America range from approximately 2.7 to 25 hectares (Dechant et al. 2002). The species is primarily monogamous, though polygyny has been documented (Yosef 1992, 1996). Young are tended by both adults; fledglings begin capturing food independently approximately two weeks after leaving the nest and continue to be fed by adults for an additional two weeks before becoming fully independent (Luukkonen 1987). Males and females defend separate territories during the nonbreeding season (NatureServe 2026).

Range

Loggerhead shrikes have a broad distribution across central and southern Canada, most of the United States, and into Mexico (Dawson 1923, Pruitt 2000, Dechant et al. 2002, Sibley 2003). The breeding range extends from California, eastern Oregon, eastern Washington, and central Alberta eastward across southern Canada to southwestern New Brunswick and Nova Scotia, and south through Mexico to Oaxaca and Veracruz, the Gulf Coast, and southern Florida (NatureServe 2026). Nonbreeding range includes central Washington, eastern Oregon, California, southern Nevada, northern Arizona, northern New Mexico, and the southern half of the breeding range east of the Rockies (NatureServe 2026). The species is resident year-round throughout the southern half of its United States range, including much of the desert southwest.

In Nevada, the loggerhead shrike is found statewide in sagebrush, desert scrub, and similar open habitats (Floyd et al. 2007). In the desert southwest, the species occupies a variety of habitat types, including shadscale in east and central Nevada (Medin 1990), sagebrush habitats in the Great Basin (McAdoo et al. 2004), Mojave Desert creosote/bursage in the West Mojave (Brooks 1999), and mixed Mojave Desert scrub in southern Nevada (Blake 1984).

In Clark County, the loggerhead shrike is widespread and relatively common. The species is a year-round resident of desert shrub communities on lower bajadas and valley bottoms and a seasonal visitor to lower mountain slopes of semi-open woodlands (Blake 1984). The species has been documented in all major ecosystem types in the county except alpine, bristlecone pine, and mixed conifer (GBBO 2015).

Habitat Characteristics

Loggerhead shrikes occupy open to semi-open habitats characterized by low vegetative height, availability of elevated perches, and access to prey. Suitable environments include open desert, sagebrush scrub, woodlands, pastures, fencerows and shelterbelts in agricultural fields, orchards, riparian areas, ranches, suburban areas, roadsides, cemeteries, and golf courses (Prescott and Collister 1993, Dechant et al. 2002). The species requires hunting perches such as prominent shrubs, fence posts, power lines, and poles, which are a critical component of suitable habitat (Yosef and Grubb 1994).

In Clark County and the broader Mojave Desert region, loggerhead shrikes are found throughout desert shrub communities dominated by creosote bush (*Larrea tridentata*), burro brush (*Ambrosia dumosa*), sagebrush (*Artemisia* spp.), or saltbush (*Atriplex* spp.) interspersed with Joshua trees, catclaw, or mesquite (SWECO 2018). Shrikes show a preference for areas of low slope and high horizontal and vertical structural diversity (Poole 1992 in Dechant et al. 2002). Vegetation associated with shrike locality records in Clark County falls predominantly within North American Warm Desert Scrub and Grassland, with Western North American Cool Semi-Desert Scrub and Grassland, and Land Use and Development as the second and third most common associations (Nussear et al. 2024).

Nesting occurs in thorny or dense shrubs and small trees that provide structural support and concealment. In the Mojave Desert region, Joshua trees (*Yucca brevifolia*), mesquite (*Prosopis* spp.), and

catclaw (*Acacia* spp.) are commonly used for nesting, as are sagebrush (*Artemisia* spp.) and greasewood (*Sarcobatus* sp.) in some Great Basin locations (Dawson 1923). Impaling stations, where prey is cached on sharp objects, have been observed 7 to 65 meters from nests and are typically protected within shrubs (Woods 1995). In southern Nevada, impaling stations are frequently located on exposed yucca leaves.

Habitat Suitability Model

A habitat suitability model for the loggerhead shrike in Clark County was developed by Nussear et al. (2024) using an ensemble modeling approach. For this species, the gradient boosting machine and random forest algorithms were included in the highest-performing model group. Model performance was high for GBM and RF algorithms, with area under the curve and true skill statistic values indicating strong discrimination between suitable and unsuitable habitat, and minimal difference between training and testing data. The ensemble model exhibited lower BI scores for training and all-data sets, while GBM and RF models had low BI scores across training, testing, and all-data sets.

Flow accumulation and slope were the variables with generally the highest relative importance across models. For the GBM model, flow accumulation contributed 65.6 percent of variable importance, and slope contributed 31.1 percent. The RF model showed more distributed importance across all variables, with flow accumulation (29.2 percent) and slope (20.9 percent) as the top contributors, followed by NDVI start of season (14.2 percent), winter precipitation (12.4 percent), and coefficient of variation of winter precipitation (12.4 percent). A vegetation-inclusive RF model was also developed; the addition of vegetation improved model performance across all metrics and contributed approximately 5 percent of variable importance, with slope and flow accumulation remaining the leading predictors (Nussear et al. 2024).

Areas of medium- and high-suitability habitat are predicted to be widespread throughout Clark County (Figure 10). The ensemble model predicted that the footprint of suitable habitat was similar whether or not vegetation was included as a modeling variable, reflecting the relatively low influence of vegetation layer on habitat predictions for this species. High-suitability habitat was predicted to encompass 143,773 acres within the county, with moderate-suitability habitat far more broadly distributed across approximately 1,946,968 acres. High-suitability habitat was found within all major ecosystem types in the county except alpine, bristlecone pine, and mixed conifer, with Mojave Desert Scrub and Blackbrush ecosystems containing the largest areas of predicted high-suitability habitat (Nussear et al. 2024).

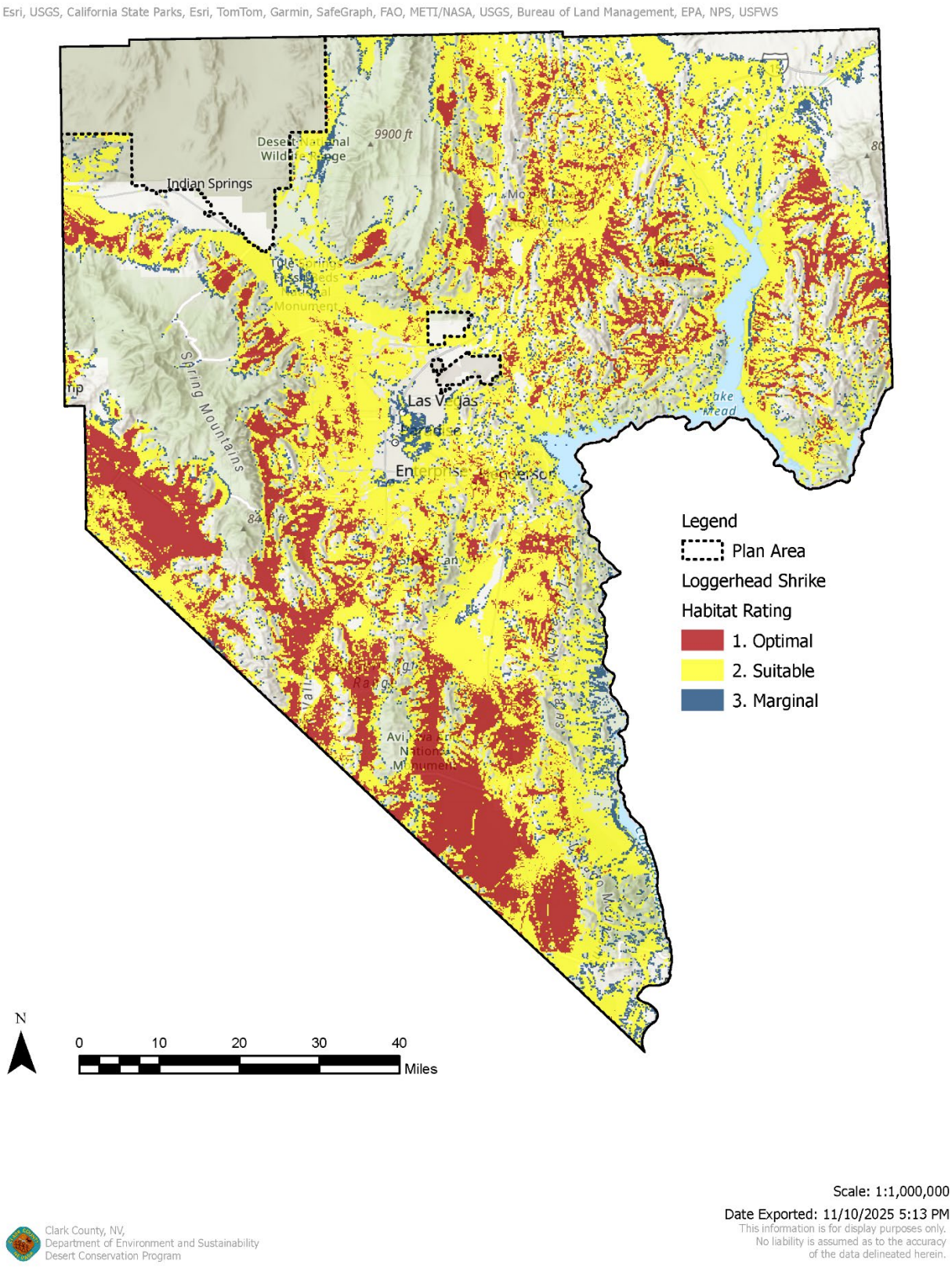

Figure 10. Habitat suitability model for the loggerhead shrike (*Lanius ludovicianus*) (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Evaluation
U.S. Fish and Wildlife Service Endangered Species Act	None
Migratory Bird Treaty Act	Protected
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	Sensitive
State of Arizona	Species of Greatest Conservation Need
State of California	Species of Special Concern
State of Utah	None
NV Division of Natural Heritage	Watch List
NV State Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Breeder/Migrant
NatureServe Global and NV State Rank	G4 S3
IUCN Red List	Near Threatened
CITES	None

The loggerhead shrike is not listed under the federal Endangered Species Act of 1973; however, the San Clemente Island, California population (subspecies *mearnsi*) is listed as Endangered by USFWS (NatureServe 2026). No petitions have been filed to list the species rangewide. The USFWS designated the loggerhead shrike as a Migratory Nongame Bird of Management Concern in 1987 due to rangewide population declines, and the species is listed as sensitive or threatened at the state level in 14 states. In Canada, the eastern population is listed as Endangered and the western (*excubitorides*) subspecies is listed as Threatened by the COSEWIC (NatureServe 2026).

NatureServe assigns the loggerhead shrike a global rank of G4 (apparently secure), reflecting that the species remains widespread with a large global population estimated at nearly six million individuals (NatureServe 2026, Partners in Flight 2013). The Nevada state rank is S3, indicating the species is vulnerable to extirpation from the state. The IUCN Red List classifies the loggerhead shrike as Near Threatened. The species has no CITES listing.

The loggerhead shrike is protected under the Migratory Bird Treaty Act. In Nevada, it is classified as a Sensitive Bird under NAC 503.050.3(e) and is identified as a Species of Conservation Priority in the Nevada State Wildlife Action Plan (NDOW 2022). The Nevada Division of Natural Heritage places the species on its Watch List. The species is also identified as a Species of Greatest Conservation Need in Arizona and a Species of Special Concern in California.

Population Trends

Loggerhead shrike populations have experienced substantial and well-documented declines across North America since at least the 1960s, with some evidence of decline beginning as early as the 1930s. North American Breeding Bird Survey data for 1966 to 2019 indicate a rangewide decline of approximately 71 percent at a rate of 3.6 percent annually (NatureServe 2026, Sauer et al. 2019), and NatureServe characterizes the long-term trend as a 70 to 90 percent decline over the past 40 years (NatureServe 2026). Regional Breeding Bird Survey data for 1966 to 2000 show declines of 78 percent in the eastern region, 65 percent in the central region, and 75 percent in the western region (NatureServe 2026). Christmas Bird Count data for 1961 to 1978 documented an additional 22 percent decline in winter sightings nationwide (Morrison 1981). While the rate of decline has slowed compared to earlier decades, it has not reversed: Breeding Bird Survey data indicate a rangewide annual decline of 1.80 percent from 2002 to 2012, with regional rates of 3 percent annually in the east and 1.9 percent annually in the central region during that period (NatureServe 2026).

Declines are well documented in the regions most relevant to Clark County. Partners in Flight estimates the loggerhead shrike population in the intermountain west region, which includes all of Nevada, declined by 48 percent between 1970 and 2014, with a more recent short-term rate of 1.3 percent annually from 2004 to 2014 (Rosenberg et al. 2016). The Sonoran Joint Venture area experienced a steeper estimated decline of 54 percent over the same long-term period (Rosenberg et al. 2016). Breeding Bird Survey data specific to the Sonoran and Mojave deserts show annual declines of 2.6 percent from 1966 to 2019 (Sauer et al. 2020). Rosenberg et al. (2016) classifies the loggerhead shrike as a “common bird in steep decline.”

While some western populations were reported as relatively stable in the 1990s (Peterjohn and Sauer 1995), more recent analyses indicate that declines are ongoing across all regions including the western United States. The exact causes of population decline remain unclear. Pesticides, loss of wintering habitat quality, habitat loss and degradation, and dependency on roadside habitat with associated high predation pressure have been identified as potential contributing factors (NatureServe 2026). Food availability may also play a role; reductions in invertebrate prey through pesticide use or habitat degradation have been implicated in some regional declines, and winter food shortages may increase vulnerability to predation by forcing birds into suboptimal habitats occupied by raptors (NatureServe 2026). Despite documented declines, the loggerhead shrike remains common enough in the southern portion of its range that most states in that region do not provide special protection or conduct population monitoring (NatureServe 2026). In Nevada and the broader American West, habitat use is still poorly understood, with multiple modeling efforts yielding no strong environmental predictors for shrike occurrence beyond a general preference for open, unforested habitat types (GBBO, unpublished data).

Habitat Level Threats

Loggerhead shrikes occupy open to semi-open desert scrub, sagebrush, and similar habitats throughout Clark County and the broader Nevada landscape, all of which are subject to multiple overlapping threats. The loss of open habitat and, specifically, of perching and nesting substrates represents the primary threat at the habitat level (Yosef 1994). Activities or processes that reduce nesting and perching substrates or diminish primary production supporting prey species are considered the most critical manageable threats to the species in the region (GBBO 2015).

Off-highway vehicle use, particularly on closed roads and trails, disrupts habitat through soil compaction and vegetation damage. Urbanization and the development of energy infrastructure, including utility-

scale solar projects, eliminate suitable breeding habitat. Habitat conversion from unimproved pasture or native shrubland to cropland has been correlated with loggerhead shrike population declines exceeding 50 percent, with more moderate conversions resulting in less severe but still significant losses (Dechant et al. 2002). Grazing by livestock and feral horses in sagebrush areas reduces shrub cover and foraging and nesting habitat suitability (NDOW 2022).

Wildfire represents a medium-level threat to loggerhead shrike habitat, particularly in shrublands not adapted to frequent fire. Increases in wildfire frequency and intensity can eliminate or degrade suitable breeding habitat. Wildfire in sagebrush steppe has been shown to reduce shrike densities and nest survivorship by approximately 50 percent (Himple and Holmes 2006). Invasive annual grasses such as cheatgrass and red brome alter natural fire regimes by promoting more frequent, larger, and more intense fires, resulting in reduced native shrub density. These changes are also correlated with reduced arthropod diversity and abundance, diminishing prey availability for loggerhead shrikes (NDOW 2022).

Threats to Species

In addition to habitat-level threats, loggerhead shrikes are subject to several species-specific threats. Some populations have demonstrated decreased reproductive success near roads, possibly associated with elevated predation pressure in linear roadside habitats and vehicle mortality of adults and fledglings (Yosef 1995, NatureServe 2026). Vehicle collisions are a locally significant source of mortality, particularly for inexperienced juvenile birds; juveniles and fledglings have been documented learning to forage along roadsides, increasing collision risk (NatureServe 2026).

Organochloride pesticides have been associated with eggshell thinning in loggerhead shrikes in some areas of the United States (Pruitt 2000). While the use of organochlorides was largely banned in the United States in the 1970s, wintering shrikes may still bioaccumulate residual organochlorides on their Mexican wintering grounds (SWECO 2018). The incidence and impact of this bioaccumulation in southern Nevada's loggerhead shrike population, which are thought to be largely non-migratory, is unclear. As top-level predators, loggerhead shrikes are susceptible to bioaccumulation of persistent agricultural chemicals and pesticides throughout the food chain (NDOW 2022). Restrictions on pesticide use in shrike habitat are recommended to avoid depression of prey availability (NatureServe 2026).

Brown-headed cowbird (*Molothrus ater*) nest parasitism has been documented in loggerhead shrikes but is relatively rare and is not considered a significant limiting factor (Dechant et al. 2002). Some evidence suggests that shrikes may be able to recognize and remove parasitic eggs from their nests (Rothstein 1982 in SWECO 2018). Predation is the leading cause of nest failure, though nest predation is not considered to constitute an important limiting factor at the rangewide scale (NatureServe 2026).

Conservation and Management

Existing conservation planning frameworks provide some guidance for loggerhead shrike management in Clark County and the broader Nevada region. The Nevada State Wildlife Action Plan identifies the loggerhead shrike as a Species of Conservation Priority and recommends maintaining suitable nesting and wintering habitat in areas of regular shrike activity, maintaining thorny shrubs, barbed-wire fences, and other objects suitable for impaling prey, and restricting pesticide use to avoid decreasing the prey base (NDOW 2022).

Partners in Flight Landbird Conservation Plan (2016 Revision) recommends generic actions for conserving loggerhead shrike populations, including reducing and preventing collisions with buildings and other structures, reducing the loss of habitats in nonbreeding areas, and implementing conservation practices

in agricultural and rangeland landscapes (Rosenberg et al. 2016). At the site level, NatureServe (2026) recommends maintaining suitable nesting habitat features including potential perch sites at densities sufficient to support territorial pairs, and discouraging vegetation management practices that remove thorny shrubs or woody vegetation that serves as nesting substrate.

Protection of desert shrub communities through land management actions that reduce surface disturbances and increase vegetation cover benefits loggerhead shrike habitat. Fencing protected areas to reduce livestock grazing and off-highway vehicle activity has been shown to result in greater perennial plant cover, increasing food and cover resources for shrikes and many other species (Brooks 1999).

Based on the habitat suitability model (Nussear et al. 2024), approximately 2,895,421 acres of suitable loggerhead shrike habitat occur within the MSHCP Amendment Plan Area. Of this total, approximately 185,454 acres (6.4 percent) of suitable habitat occur within the MSHCP Amendment Impact Area. Approximately 1,493,050 acres (51.6 percent) of suitable habitat occur within lands managed for resource conservation, and 81,690 acres (2.8 percent) occur within the existing MSHCP Reserve System. An additional 232,540 acres (8.0 percent) of suitable habitat are located within proposed MSHCP Amendment Reserve System Additions.

Loggerhead shrike (*Lanius ludovicianus*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	2,895,421	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	185,454	6.4%
Suitable Habitat in Lands Managed for Resource Conservation	1,493,050	51.6%
Suitable Habitat in the existing MSHCP Reserve System	81,690	2.8%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	232,540	8.0%

*Nussear et al. 2024

Clark County Survey Data

Great Basin Bird Observatory (GBBO) avian point-count surveys conducted over a six-year period in Clark County used point-count transects to generate density estimates for loggerhead shrikes across dominant vegetation types in the county. Highest densities were found in desert riparian habitat, with disturbed areas and Mesquite/Acacia habitat ranking as the second and third highest-density vegetation associations (Ammon 2015). Statistical analysis indicated that shrikes selected habitats including cheesebush, cliffrose, and dry washes, with nearby trees (Ammon 2015). Logistic ANOVA models indicated the importance of specific structural features for shrike occurrence beyond broad vegetation associations.

Avian surveys conducted by SWCA Environmental Consultants between 2018 and 2025 documented loggerhead shrikes at multiple locations in Clark County. Surveys conducted in 2018 detected the species within Mojave Desert scrub habitat at the Boulder City Conservation Easement. Subsequent surveys conducted between 2022 and 2025 confirmed continued presence of the species at the Boulder City Conservation Easement and documented the species in desert riparian habitat in the Riverside and Mormon Mesa area of the Virgin River (SWCA 2022, 2024, 2025). These detections are consistent with the species' documented preference for desert scrub and riparian habitats in Clark County.

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Yuma Ridgway's Rail (*Rallus obsoletus yumanensis*)

Photo Credit: Brian Small Photography

Species Overview

Ridgway's (Yuma) rail was previously classified as a subspecies of clapper rail (*Rallus longirostris yumanensis*), but is now classified as a subspecies of Ridgway's rail (*Rallus obsoletus*) following revisions to the American Ornithological Society's Check-list (Chesser et al. 2014, Maley and Brumfield 2013). The common name also changed from "Yuma clapper rail" to "Yuma Ridgway's rail" when this reclassification was formally recognized in 2014. The Yuma subspecies is the only subspecies of Ridgway's rail present in Clark County, Nevada, and represents the northernmost occurrences of the subspecies rangewide.

The species is a medium-to-large rail, approximately 20 to 23 cm in height and averaging approximately 250 g, with males slightly larger than females. Plumage is identical in both sexes: the back is gray-brown to rusty-cinnamon with edging of grayish coloring, and the breast is bright rufous. The body is laterally compressed, the bill slightly decurved, and the legs and toes are relatively long. Like other rails, it is a secretive bird and is more often heard than seen, with dense marsh vegetation providing camouflage and cover (USFWS 2009).

The diet consists primarily of crayfish, mussels, clams, isopods, freshwater shrimp, fish, beetles, and various other insects. Foraging occurs within emergent vegetation, mostly by sight, surface-gleaning, or shallow probing (Eddleman and Conway 2020). The species is monogamous, and both sexes participate in incubation and brood-rearing. Nesting typically occurs between March and July, with an average clutch size of 5 to 11 eggs. Males construct the relatively large nests, usually placed in clumps of emergent plants or at the base of small shrubs within dense cover. Incubation lasts approximately 23 to 28 days, and young are semi-precocial, leaving the nest shortly after hatching and receiving parental care for 5 to 6 weeks (Eddleman and Conway 2020). Young are capable of flight in approximately 9 to 10 weeks (Nussear and Simandle 2020). Life span is unknown (NDOW 2022).

The Yuma Ridgway's rail is the only subspecies of Ridgway's rail known to occupy freshwater marshes during the breeding season. Most of the U.S. breeding population is considered resident, though recent satellite telemetry work has revealed that some individuals undertake seasonal movements to coastal areas in Mexico during winter months, with departure from breeding areas appearing to occur in October (Harrity and Conway 2020). In Nevada, the subspecies is most active during the breeding season and post-breeding period, generally March through October. Nevada individuals were previously believed to be year-round residents, but recent telemetry work has shown that at least some individuals likely migrate during winter months (NDOW 2022).

Range

The Yuma Ridgway's rail occurs from the Colorado River Delta in Mexico northward along the Colorado River and its tributaries, including the Salton Sea region in Imperial County, California, and portions of Arizona and Nevada. There are three subspecies of Ridgway's rail in the United States: the California Ridgway's rail (*R. o. obsoletus*) in the San Francisco Bay area, the light-footed Ridgway's rail (*R. o. levipes*) in coastal southern California, and the Yuma Ridgway's rail (*R. o. yumanensis*), found along the lower Colorado River and its tributaries and around the Salton Sea (Maley and Brumfield 2013). Additional subspecies occur in Mexico (Pranty et al. 2014). According to NatureServe, the rangewide breeding distribution encompasses approximately 101,000 km² based on records from the past 20 years (NatureServe 2024).

The subspecies is organized into five population centers across 14 watersheds within the Colorado River Basin. Three of these are considered core population areas: the lower Colorado River (with the highest densities at the Imperial, Cibola, and Havasu National Wildlife Refuges), the Salton Sea in California, and the Ciénega de Santa Clara in Sonora, Mexico, which supports more than 70 percent of the global population. Two smaller, peripheral populations occur along the lower Gila and Salt Rivers in central Arizona and along the Las Vegas Wash in southern Nevada (NatureServe 2024).

In Nevada, detections have been documented as far north as Key Pittman Wildlife Management Area and Pahranagat National Wildlife Refuge in Lincoln County, along the Virgin River south of Mesquite to the upper end of Lake Mead, at OWMA in Clark County, and west to Ash Meadows National Wildlife Refuge in Nye County (NatureServe 2024). It is uncertain whether the rail occurred in Nevada prior to the creation of the Colorado River reservoir system. In Clark County, this species occurs along the Virgin and Muddy Rivers, the lower Colorado River system, and the Las Vegas Wash (Garnett et al. 2004, van Dooremolen 2015).

Habitat Characteristics

The Yuma Ridgway's rail is an obligate wetland species with narrow habitat requirements. It occupies freshwater and alkali marshes dominated by stands of emergent vegetation, interspersed with areas of open water and drier, upland benches (Eddleman and Conway 2020). The subspecies shows a preference for moderately dense stands of cattail (*Typha* spp.) and bulrush (*Scirpus* / *Schoenoplectus* spp.), and avoids both open water and densely overgrown stands (USFWS 1983). Sedges (*Cyperaceae*) also contribute to nesting cover. The species requires a wet substrate, such as mudflats or drainage bottoms, that is densely vegetated; vegetation density is considered the critical element for suitable nesting habitat.

Nests are typically placed in clumps of emergent plants, on dry hummocks, or at the base of small shrubs within dense cover, and may include a woven canopy of vegetation overhead and a ramp of plant material leading to the nest entrance. The species forages along the ecotone between mudflats and higher vegetated zones, and in tidal sloughs (BirdLife International 2020). Within Clark County, this subspecies occurs in marshes along rivers, backwaters, and drains or sumps supported by irrigation water and is found at elevations ranging from below sea level to approximately 1,300 feet (Nussear and Simandle 2020).

Winter habitat in Nevada is similar to breeding habitat. Migratory stopover events have been documented in sparse desert areas, including desert arroyos with creosote (*Larrea tridentata*), mesquite (*Prosopis* spp.), and other upland vegetation, as well as agricultural fields (Harrity and Conway 2020).

Habitat Suitability Model

Simandle and Nussear (2025) developed ensemble habitat suitability models for the Yuma Ridgway's rail using species occurrence records, Clark County vegetation classifications, and environmental predictor variables including soil properties, climatic variables, and remotely sensed indices. Two ensemble model configurations were developed: one incorporating Clark County vegetation divisions within the county boundary, and one without vegetation divisions using a buffered modeling area extending beyond county limits.

Both ensemble model configurations performed with high reliability, achieving perfect rank discrimination across thresholds (AUC = 1.0000, TSS = 1.0000) on the testing dataset. The locality data used for model development consisted of 87 occurrence records; spatial thinning reduced the number used for training and testing to between 11 and 68 records depending on the model configuration. The authors note that caution should be applied when interpreting predictions in and around the City of Las Vegas, because the environmental predictor variables used are not correctly represented in urban areas.

The most influential variables in the ensemble models were the first principal component of sand, silt, and clay composition (soil1); the coefficient of variation in minimum temperature (CVMinTemp); maximum vapor pressure deficit (vpdMax); and the coefficient of variation in winter precipitation (wpcv). Habitat suitability was highest in areas with fine-textured soils (low soil1 values), greater variability in minimum temperature, higher vapor pressure deficit, and greater variability in winter precipitation.

Areas of high habitat suitability for the Yuma Ridgway's rail are rare and narrowly distributed in Clark County. In the model incorporating Clark County vegetation divisions, highly suitable habitat is concentrated on the eastern side of the City of Las Vegas, though urban area predictions should be interpreted with caution. In the buffered model, highly suitable habitat is distributed at lower elevations along the Meadow Valley Wash, the Muddy River, the Virgin River, and northern shores of Lake Mead. Additional areas of highly suitable habitat occur along the Colorado River in the Cottonwood Valley, near Bullhead City in the Mohave Valley, and in the southeast end of the Amargosa Desert (Simandle and Nussear 2025). High-suitability habitat is absent from high-elevation areas. The ensemble habitat suitability model for the Yuma Ridgway's rail in the vicinity of Clark County is shown in Figure 11.

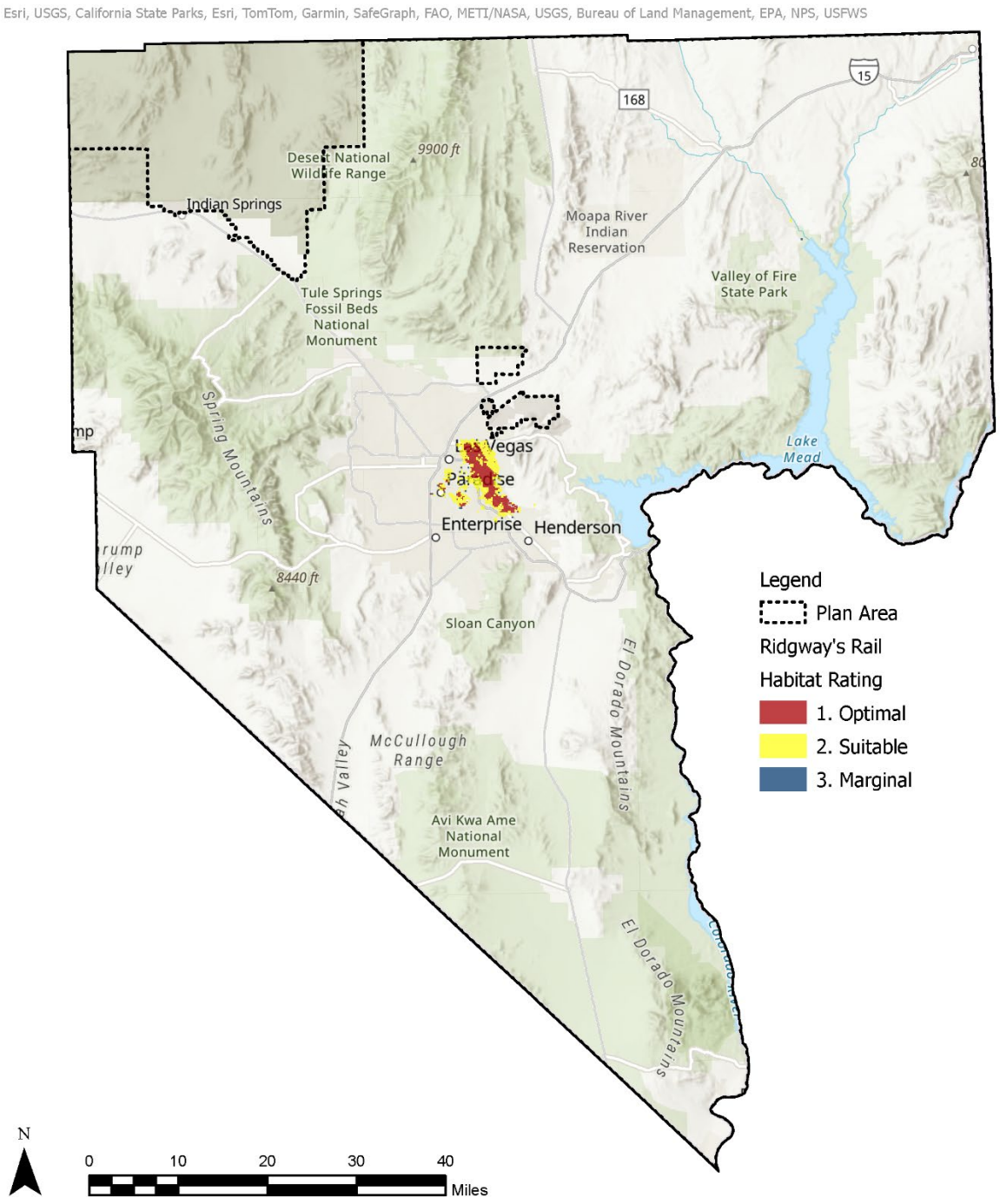

Figure 11. Habitat suitability model for Yuma Ridgway's rail (*Rallus obsoletus yumanensis*) in Clark County, Nevada (Simandle and Nussear 2025).

Species Status

Agency/Organization	Status
MSHCP (2000)	Watch List
U.S. Fish and Wildlife Service Endangered Species Act	Endangered
Migratory Bird Treaty Act	Protected
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	Endangered
State of California	Threatened
State of Arizona	Species of Greatest Conservation Need
State of Utah	None
NV Division of Natural Heritage	At Risk
NV State Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Presumed Stable
NatureServe Global and NV State Rank	G3T3 S1B
IUCN Red List	Near Threatened
CITES	No Status

The Yuma Ridgway's rail has been federally listed as endangered since March 11, 1967, initially under the Endangered Species Preservation Act of 1966 and subsequently under the Endangered Species Act of 1973. The subspecies was listed under the synonym *Rallus longirostris yumanensis*; USFWS updated the taxonomy to *Rallus obsoletus yumanensis* in 2021. A down-listing proposal was prepared in 1983, but flooding of important rail habitat on the lower Colorado River that year prevented publication, and instability of population numbers after 1983 precluded reconsideration (Nussear and Simandle 2020). In 2022, USFWS initiated a 5-year status review of the subspecies (USFWS 2022). A 2023 technical correction clarified that Endangered Species Act protections apply to the full subspecies and are not limited to a discrete population segment (USFWS 2023). The subspecies is also protected under the Migratory Bird Treaty Act of 1918 and is listed as endangered in Arizona, California, and Nevada.

NatureServe assigns a global rank of G3T3 (Vulnerable subspecies), reflecting a small breeding range in the southwestern United States and northwestern Mexico, substantial population declines since the early 1900s due to habitat degradation and loss, and ongoing threats to remaining wetland habitat. State ranks are S1 in both California and Nevada (critically imperiled) and S3 in Arizona (vulnerable). Nevada's state rank is S1B, indicating critical imperilment as a breeding subspecies. The most recent review of NatureServe global conservation status factors was conducted on April 12, 2024 (NatureServe 2024).

The IUCN Red List evaluates Ridgway's rail at the species level (*Rallus obsoletus*) as Near Threatened, reflecting a moderately small population considered to be declining due to habitat losses from agriculture

and other development (BirdLife International 2020). The subspecies has no CITES listing. In Nevada, the species is designated a Species of Greatest Conservation Need in the 2022 Nevada State Wildlife Action Plan (NDOW 2022) and is ranked T3S1B by the Nevada Natural Heritage Program.

Population Trends

Variable survey methods and locations have made it difficult to accurately estimate population trends for the Yuma Ridgway's rail (Nussear and Simandle 2020). The long-term trend is characterized as a decline of 50 to 80 percent since the early 1900s, driven primarily by habitat loss and degradation; however, reliable long-term trend data are lacking because dedicated survey work was limited prior to the subspecies being federally listed (NatureServe 2024). Historical population estimates for the United States ranged from 400 to 1,000 individuals in the 1960s through mid-1970s, and 500 to 1,000 birds from 1990 to 2005, with Ehrlich et al. (1992) estimating 1,700 to 2,000 individuals. USFWS reported a U.S. total of 641 individuals based on compiled survey data from 1969 to 2007.

Despite the long-term decline, recent data suggest the population may be stabilizing or rebounding in parts of the range. Rangewide relative abundance increased from approximately 432 individuals in 2015 to 839 in 2019, the highest count recorded in over a decade. NatureServe characterizes the short-term trend as relatively stable (10 percent or less change). This apparent recovery is attributed to marsh restoration and management efforts and increased and more standardized survey effort across the range (NatureServe 2024).

The global population is estimated at approximately 10,000 individuals. The Ciénega de Santa Clara in Sonora, Mexico, supports more than 70 percent of the global population, with an estimated approximately 8,600 individuals. That population has fluctuated between 1999 and 2022 but has remained broadly stable, averaging 2.09 rails per point count (NatureServe 2024). Population estimates fluctuate annually due to dynamic habitat conditions, varying survey protocols, and differing surveyor effort (NatureServe 2024).

Trends in Nevada are poorly known. The 2022 Nevada State Wildlife Action Plan characterizes the population trend in Nevada as unknown, noting that while the subspecies declined significantly rangewide between 1970 and 1990, Nevada-specific trend data are lacking (NDOW 2022). Nevada individuals represent the northernmost occurrences of the subspecies.

Habitat Level Threats

The most immediate threat to the Yuma Ridgway's rail is the continued loss, degradation, and fragmentation of its wetland habitat. The conversion of wetlands for industrial, agricultural, salt production, and urban development has drastically reduced the extent of available marsh habitat across the subspecies' range. In southern California alone, coastal saltmarsh habitat loss is estimated at 75 to 90 percent since European settlement (NatureServe 2024).

Water management and diversion practices represent a high-level threat, as water diversions can lead to the loss or degradation of marshes and decline in water quality. In Arizona, this subspecies is threatened by habitat fragmentation from river channelization, dredging, drying and flooding of marshes, and diversion of water sources. The Ciénega de Santa Clara in Mexico faces the potential diversion of its water supply to the Yuma Desalting Plant in Arizona (NatureServe 2024).

Persistent drought and increasingly unpredictable storm and flooding events associated with changing climate conditions can degrade or eliminate emergent marsh vegetation. While existing changes in climate

conditions do not appear to have yet negatively affected Yuma Ridgway's rails, projected future water shortages in the Colorado River may affect rail populations (USFWS 2009). Pollution from heavy metal and pesticide runoff from agricultural, industrial, and urban sources can degrade water quality and introduce contaminants harmful to the health and breeding success of the subspecies (NDOW 2022).

Within Clark County, most of the rail's habitat is within the Virgin and Muddy River 100-year flood plains, areas that include some agricultural land and potential contaminants from urban runoff from the cities of Mesquite, Nevada, and communities in Washington County, Utah (Nussear and Simandle 2020). Threats to the subspecies are largely due to habitat losses associated with water management, alteration of marsh habitats, and conversion to other anthropogenic uses.

Threats to Species

Selenium contamination is a significant threat to the Yuma Ridgway's rail within its range. High levels of selenium can result in acute toxicity, chronic poisoning, tissue damage, and reproductive impairment in birds. The subspecies accumulates selenium through consumption of contaminated invertebrates and fish; potential poisoning from selenium is considered a likely significant threat in the Imperial Valley, California, though the specific effects on this subspecies remain incompletely understood (NatureServe 2024, Nussear and Simandle 2020).

Chigger mite infestations represent a novel threat, with infestations documented in up to 92 percent of some subpopulations in southwestern Arizona and Nevada (Harrity and Conway 2019, NatureServe 2024). Incidental mortality at solar energy facilities has also been documented (Harrity and Conway 2020). Urban expansion increases the risk of encroachment on emergent marsh habitat, channelization of nearby aquatic systems, and elevated populations of feral and human-associated wildlife such as feral cats, coyotes, and raccoons that may prey on rails or their eggs (NDOW 2022).

The Ciénega de Santa Clara population in Mexico is considered the source population for the subspecies throughout the remainder of its range. The inadequacy of existing regulatory mechanisms to protect the Ciénega from diversion of its water supply represents a rangewide threat. A population decline of approximately 23 percent was observed at this site between 1999 and 2002. Conservation of the subspecies requires maintenance of water flows and successional habitat stages throughout the region, and will require binational collaboration to secure water supplies for key wetland areas (NatureServe 2024).

Conservation and Management

Conservation measures for the Yuma Ridgway's rail are addressed in the Yuma Clapper Rail Recovery Plan of 1983 (USFWS 1983). The plan establishes goals of maintaining a stable population of 700 to 1,000 individuals, preserving habitat, and carrying out public education efforts. It recommends maintaining consistent water levels in marshes in the Virgin and Muddy River valleys, controlling invasive plants, controlling nest predators when unusual predation is documented, and continuing surveys and research to better determine population trends, threats, and habitat requirements. A draft revision to the recovery plan was released by USFWS in 2010 but no further action on the revision has been taken. The revision includes additional scientific information and provides criteria and actions needed to delist the subspecies. Critical habitat has not yet been designated (Nussear and Simandle 2020).

The Yuma Ridgway's rail is listed as a covered species under the Lower Colorado River Multi-Species Conservation Plan (LCR MSCP), a 50-year comprehensive habitat conservation plan addressing the effects of water use and hydropower generation along the lower Colorado River on 26 species. Conservation measures

in this plan include the creation of 512 acres of habitat and the maintenance of existing habitat (Nussear and Simandle 2020).

In Nevada, the Las Vegas Wash Coordination Committee has increased wetland habitat availability by planting bulrush in the constructed impoundments and along the Wash's banks, with cattails and common reed volunteering from upstream sources. Clark County has also created emergent wetlands through constructed wetland ponds in the Wetlands Park Nature Preserve and in-lieu fee mitigation wetlands (van Dooremolen et al. 2024). The Nevada Comprehensive Bird Conservation Plan recommends creating artificial wetlands where habitat parameters are suitable, using prescribed fire in overgrown marshes, and conducting studies to determine whether seasonal movements occur.

The 2022 Nevada State Wildlife Action Plan identifies two primary research and monitoring needs for this subspecies in Nevada: a better understanding of migration patterns and the extent to which local individuals migrate or winter on their breeding grounds, and enhanced survey and monitoring efforts to verify breeding timing in Nevada and assess breeding success and other demographic parameters (NDOW 2022).

Within the MSHCP Amendment Plan Area, Simandle and Nussear (2025) modeled 16,338 acres of suitable habitat for the Yuma Ridgway's rail. The distribution of that suitable habitat relative to impact areas, conservation lands, and reserve units is summarized in the table below.

Yuma Ridgway's rail (*Rallus obsoletus yumanensis*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	16,338	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	267	1.6%
Suitable Habitat in Lands Managed for Resource Conservation	303	1.9%
Suitable Habitat in the existing MSHCP Reserve System	0	0.0%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	0	0.0%

*Source: Simandle and Nussear 2025

Clark County Survey Data

In Clark County, Yuma Ridgway's rail occurrences are concentrated within freshwater marshes along the Virgin, Muddy, and Colorado Rivers, as well as the Las Vegas Wash (Simandle and Nussear 2025). Surveys have documented the species at Big Marsh along the western portion of the Virgin River, one of the seven Important Bird Areas of Clark County; nesting of multiple pairs at this location was confirmed in 2001 (Nussear and Simandle 2020). The Lower Virgin River and Muddy River areas are considered among the more important areas for the rail within Clark County, with regular, though reportedly decreasing, occurrences documented by Garnett et al. (2004) between 1999 and 2003, with counts ranging from 2 to 32 individuals in any given year and an average of 13.6 individuals.

Targeted surveys for Yuma Ridgway's rail have been conducted along Las Vegas Wash since 2000. In 2008, targeted Ridgway's rail surveys transitioned to a secretive marsh bird protocol targeting six species: American bittern, least bittern, black rail, Virginia rail, sora, and Ridgway's rail. Surveys are conducted in April and May (LVWASH 2026, NDOW 2022). Single individuals were recorded in 1998, 2005 to 2006, 2015 to 2017, and 2020. Prior to 2021, no more than one individual had been confirmed in the Las Vegas Wash project area in

any given year. In 2021, five individuals were detected at survey sites along the Wash, marking a notable increase. Seven individuals were documented in 2022, and six in 2023 (van Dooremolen et al. 2024, GBBO 2024, LVWASH 2026). This recent increase in detections along Las Vegas Wash is associated with active habitat enhancement by the Las Vegas Wash Coordination Committee (LVWCC) and Clark County, including bulrush plantings and construction of wetland ponds in the Wetlands Park Nature Preserve and in-lieu fee mitigation wetlands (van Dooremolen et al. 2024).

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Bendire's Thrasher (*Toxostoma bendirei*)

Photo Credit: Brian Small Photography

Photo Credit: Justin Streit, SWCA

Species Overview

Bendire's thrasher (*Toxostoma bendirei*) is a medium-sized songbird in the family Mimidae, the mimic thrushes. The species is distinguished by its long tail, mostly drab to olive-brown plumage, slightly curved dark-neutral grey bill that is usually pale at the base, and pale yellow iris that may be darker in some individuals (NDOW 2022). Bendire's thrasher is similar in size and general appearance to other desert thrashers in the genus *Toxostoma*, as well as to the Northern Mockingbird (*Mimus polyglottos*), which is abundant in urban areas of southern Nevada. Like other thrashers, Bendire's thrasher typically perches on vegetation to sing and drops to ground level when disturbed (Fisher 1903). It may be less vocal than related species, but can be attracted by playback of vocalizations (Fletcher 2009).

The species is found in open, arid shrublands and desert scrub habitats, where it forages primarily on the ground for invertebrates (particularly insects such as caterpillars, beetles, grasshoppers, ants, and termites), as well as berries and other plant material (NatureServe 2026). Bendire's thrasher breeds early in the season. The first brood is typically initiated from March through early April. Up to three broods per season are possible, though two is more common (Brown 1901). Clutch size is typically three to four eggs, rarely five (NatureServe 2026). Young leave the nest approximately 12 days after hatching (NDOW 2022). Breeding territories average approximately 1.67 ha (range 0.27 to 3.65 ha), which is comparable in size to those of other desert thrashers, including Curve-billed thrasher (approximately 2 ha) and Crissal thrasher (approximately 2.6 ha) (Desmond and Sutton 2017). Territory size varies with annual precipitation, with higher precipitation associated with smaller territories, likely reflecting greater invertebrate prey availability (Desmond and Sutton 2017). Following the breeding season, most individuals depart Nevada and migrate to southern Arizona and Sonora, Mexico, with most birds departing breeding areas in late July through August and returning in February (NDOW 2022).

Bendire's thrasher nests are built low in vegetation, typically in shrubs (e.g., *Lycium* spp.), cactus (e.g., cholla, *Cylindropuntia* spp.), desert trees (e.g., *Acacia greggii*, *Prosopis* spp.), or tree yuccas (*Yucca brevifolia* and *Y. schidigera*), approximately 1 meter above the ground surface, though nests may be placed as low as 0.15 m or as high as 6 m (Brown 1901, Gilman 1909, Gullion et al. 1959). The nest exterior is woven from interlaced twigs with an interior lined with grasses, feathers, and fine materials (Gilman 1909). All confirmed nests in Nevada have been found in cactus or other spiny vegetation (NDOW 2022).

Range

Bendire's thrasher has an estimated global range of approximately 480,634 km² (Restrepo and Arango 2008). Breeding populations are resident in southern Utah and Colorado, western New Mexico, the northern half of Arizona, southern Nevada, and the eastern Mojave Desert of California. The species is migratory, with northern breeding populations withdrawing from the Mojave and Great Basin Deserts, Colorado Plateau, and the Arizona/New Mexico Plateau, moving south in September and returning by early February (NatureServe 2026). Non-breeding areas include southern Arizona and extreme southwestern New Mexico south through Sonora to northern Sinaloa (NatureServe 2026). Overall, the species occurs in the North American warm deserts from the southwestern United States into Sonora and Sinaloa, Mexico (England and Laudenslayer 2020).

In Nevada, Bendire's thrasher is limited to the southern portion of the state in the Mojave Desert, where cactus and yucca landscapes are most common. Most location records come from Clark, Nye, and Lincoln counties, and the species is considered very rare on the landscape even within its preferred habitat type (NDOW 2022). The majority of observations occur in southern Clark County in upland mixed Mojave desert scrub habitat, as well as in adjacent San Bernardino County, California (GBBO 2010, Shuford and Gardali 2008).

Within Clark County, Bendire's thrasher is largely restricted to the western half of the southernmost portions of the county, with additional localities along the lower slopes of the Sheep and Spring Ranges. Scattered records also exist in the northern and eastern portions of the county, including near Mesquite, although these are generally outside areas of highest predicted habitat suitability (Nussear and Simandle 2020).

Habitat Characteristics

Bendire's thrasher uses a variety of desert habitats characterized by the presence of fairly large shrubs, cacti, or open woodland with scattered shrubs and trees, with open ground between (NatureServe 2026). The species is absent from areas with dense vegetation such as riparian woodlands, and avoids uninterrupted brushy cover and continuous grassland (NatureServe 2026). In the Mojave Desert and at the northern extent of its range, the species is strongly associated with intact desert scrub vegetation featuring scattered large shrubs and spinescent plants. Key structural elements across occupied habitats include at least one large individual of a cholla (*Cylindropuntia* spp.), yucca, or spinescent shrub such as palo verde, mesquite, catclaw acacia (*Senegalia wrightii*), or desert-thorn (*Lycium* spp.) (England and Laudenslayer 2020).

In Nevada, Bendire's thrasher is sparsely distributed and associated with stands of yucca and cholla indicative of upland mixed Mojave desert scrub habitats, and is likely restricted to those habitats (GBBO 2010). Most Nevada records are from Joshua tree and yucca landscapes featuring abundant cholla (NDOW 2022). The species may also occur in blackbrush (in association with yuccas), desert riparian, mesquite/acacia, Mojave desert scrub, and salt desert scrub habitats within Clark County (Brown 1901, Gilman 1909, Gullion et al. 1959). The Mojave Desert population of Bendire's thrasher is distinctly associated with intact desert vegetation, in contrast to the Sonoran Desert population, which sometimes uses abandoned agricultural areas and modified habitats (NDOW 2022).

Typical elevational range is from sea level to 1,800 m, though at least one individual has been documented at 2,560 m in Clark Canyon in the Spring Mountains (Austin and Bradley 1965). Habitat selection may also be influenced by competition with other thrashers in the same genus, including LeConte's Thrasher (*T. lecontei*) and Crissal Thrasher (*T. crissale*), which occupy areas of overlapping habitat (Nussear and Simandle 2020).

At the territory scale, Bendire's thrasher selects for habitat heterogeneity, favoring areas with taller shrubs, greater vegetation density, and more bare ground compared to randomly sampled points within the same broad habitat types. A quantitative study of breeding territories in New Mexico and Arizona found that average shrub height was the most influential variable at the territory scale, with the odds of territory selection increasing by approximately 257 percent with each 1-meter increase in shrub height (Desmond and Sutton 2017). Vegetation density (visual obstruction) and percent bare ground were also important predictors, with greater obstruction and more bare ground both positively associated with territory selection. Territories had an average of approximately 23 percent bare ground, compared to approximately 20 percent at random points, and average shrub height within territories was approximately 2.1 meters compared to 1.7 meters at random points (Desmond and Sutton 2017). These results are consistent with prior observations of the species' preference for taller spinescent plants such as Joshua trees and palo verde, and with its foraging behavior of probing bare ground for invertebrates.

At the landscape scale, Bendire's thrasher functions as an edge-adapted species, selecting territories surrounded by smaller, more disconnected habitat patches and greater variation in habitat types. Territories in the New Mexico and Arizona study were characterized by smaller mean patch size and higher patch richness within a 1-km buffer compared to random locations, indicating a preference for heterogeneous landscapes over large expanses of uniform vegetation such as dense creosote bush or heavy mesquite stands (Desmond and Sutton 2017; NatureServe 2026). These landscape-level findings are consistent with the documented avoidance of uninterrupted brushy cover and continuous grassland, and with accounts of the species using agricultural and rural development edges where taller native shrubs are maintained (NatureServe 2026). Large-scale habitat conversion to dense shrublands through woody shrub encroachment is therefore considered detrimental at both the territory and landscape scales (Desmond and Sutton 2017).

Habitat Suitability Model

Nussear et al. (2024) developed a species distribution model for Bendire's thrasher using ensemble modeling methods that combined RF, GBM, GAM, and MaxEnt algorithms. The ensemble model achieved excellent performance with high Area Under the Curve, BI, and TSS scores, showing little drop from training to testing datasets (Nussear et al. 2024). A vegetation-inclusive version of the model was also developed, which showed increased habitat prediction area particularly in the northeastern portion of Clark County.

The primary environmental variables driving model predictions were winter precipitation and its coefficient of variation, which were the highest-performing variables across most algorithms, along with slope, vegetative productivity indices (NDVI amplitude and NDVI maximum), and flow accumulation (Nussear et al. 2024). The vegetation layer, when included, contributed substantially to the RF and GBM models. The coefficient of variation of winter precipitation was the dominant variable in the MaxEnt model, contributing approximately 97 percent of the model's predictive weight. These results indicate that habitat suitability for Bendire's thrasher in Clark County is strongly governed by precipitation variability and the structural characteristics of desert scrub vegetation.

Vegetation associations at Bendire's thrasher locality points were predominantly western North American cool semi-desert scrub and grassland, and North American warm desert scrub and grassland (Nussear et al. 2024). High-suitability habitat predicted by the ensemble model is largely concentrated in the western half of the southernmost portions of Clark County, consistent with known distribution in upland Mojave Desert scrub and blackbrush ecosystems, with some additional suitability predicted along bajadas surrounding the Spring and Sheep Ranges and near Mesquite (Nussear et al. 2024). The predicted distribution of high suitability habitat is shown in Figure 12.

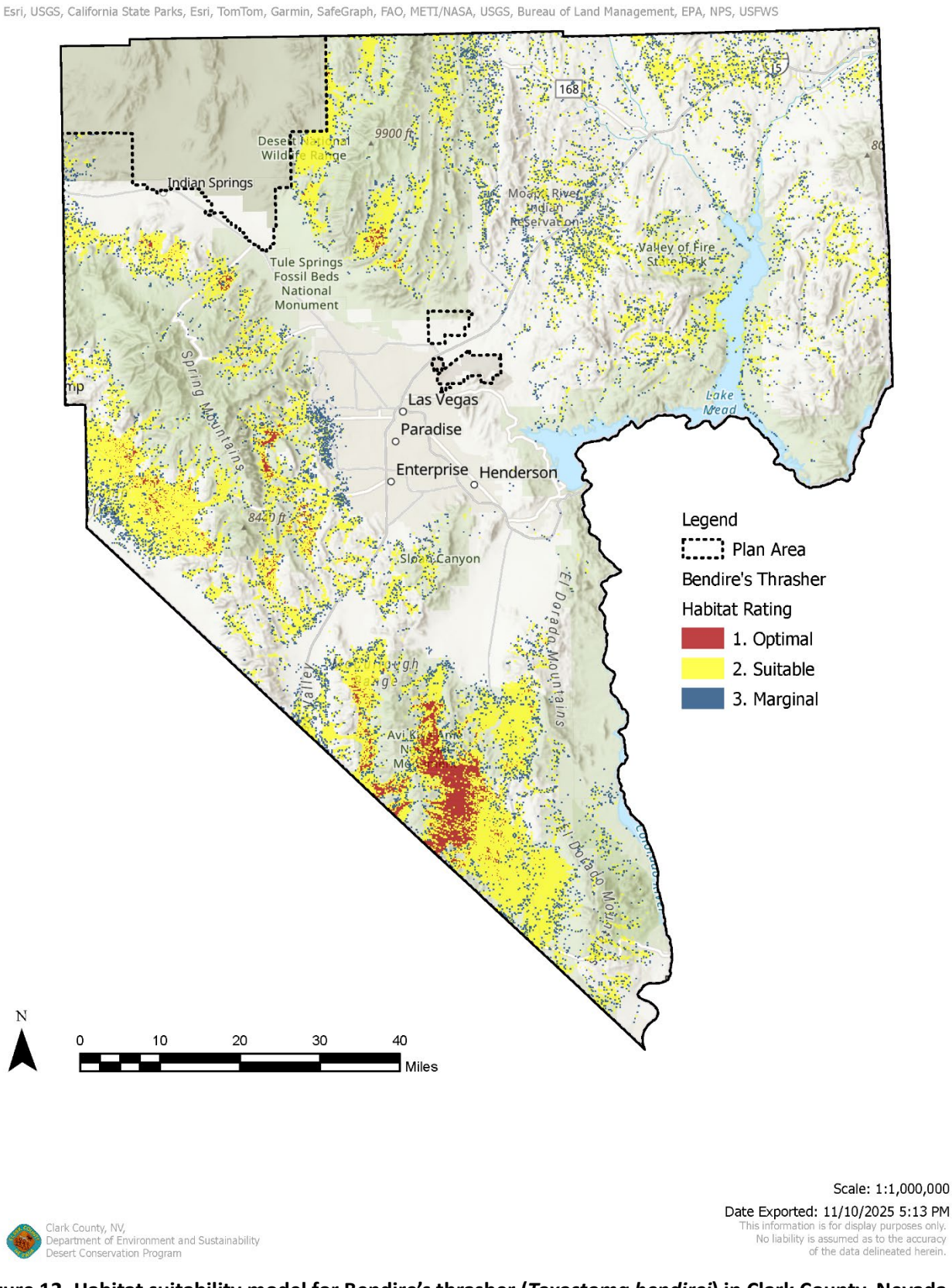

Figure 12. Habitat suitability model for Bendire's thrasher (*Toxostoma bendirei*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Evaluation
U.S. Fish and Wildlife Service Endangered Species Act	Not Listed; petition to list as Threatened or Endangered received May 2025
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	None
State of Arizona	Species of Greatest Conservation Need
State of California	Candidate Endangered/Threatened; Species of Special Concern
State of Utah	Species of Greatest Conservation Need
NV Division of Natural Heritage	At Risk
NV State Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Presumed Stable
NatureServe Global and NV State Rank	G4 S1B
IUCN Red List	Vulnerable
CITES	No Status

Bendire's thrasher carries no federal listing under the Endangered Species Act, but is designated a BLM Sensitive species in Nevada and has been identified as a USFWS Bird Species of Conservation Priority (NDOW 2022; USFWS 2008). On May 20, 2025, the Center for Biological Diversity petitioned the USFWS to list Bendire's thrasher as Threatened or Endangered under the Endangered Species Act across its range, which includes Arizona, California, Colorado, Nevada, New Mexico, Utah, and Mexico (USFWS 2025). The petition remains under review, and the species is currently designated as Not Listed. At the California state level, on April 16, 2026, the California Fish and Game Commission voted to designate Bendire's thrasher as a candidate species under the California Endangered Species Act. Candidate status confers the full protections of California Endangered Species Act, including the prohibition on take, while the California Department of Fish and Wildlife completes a 12- to 18-month status review and the Commission determines whether to list the species as threatened or endangered. California also continues to designate Bendire's thrasher a Species of Special Concern. The species carries no CITES status.

NatureServe assigns the species a global rank of G4 (Apparently Secure), reflecting its overall range breadth, though state-level ranks reflect significant regional concern: Nevada S1B (Critically Imperiled, breeding), California S2 (Imperiled), Arizona S3 (Vulnerable), New Mexico S3 (Vulnerable), and Utah S1 (Critically Imperiled) (NatureServe 2026). The Nevada Natural Heritage Program lists the species as At Risk. The 2022 Nevada State Wildlife Action Plan designates Bendire's thrasher as a Species of Greatest Conservation Need (NDOW 2022). The IUCN Red List classifies the species as Vulnerable (BirdLife International 2012).

At the continental scale, Partners in Flight has designated Bendire's thrasher a Red Watch List species with high vulnerability and a recognized need for population recovery, with an estimated continental population decline of 86 percent between 1970 and 2014 (NDOW 2022).

Population Trends

Population trend data for Bendire's thrasher consistently indicate long-term declines across the species' range, though estimates vary by analysis period and region. North American Breeding Bird Survey data indicate a significant survey-wide average annual decline of approximately 4.0 percent over the 30-year period from 1966 to 1996, with detections recorded on only 35 routes across five states, reflecting a low overall sample size (NatureServe 2026). More recent Breeding Bird Survey analysis documents a 2.8 percent average annual decline across the southwestern United States from 1966 to 2019 (NDOW 2022).

Partners in Flight analysis estimated a continental population decline of 86 percent between 1970 and 2014 (NDOW 2022). In the area covered by desert scrub within the Sonoran Joint Venture, the species declined by an estimated 78 percent over the same period (NDOW 2022). In New Mexico, where approximately 28.7 percent of the global population is estimated to occur, Breeding Bird Survey data indicate an average annual decline of 4.4 percent, with projections suggesting range-wide declines of 30 percent within 15 years and 50 percent within 20 years from the time of analysis (Desmond and Sutton 2017). Earlier analysis of Breeding Bird Survey data for the 1966 to 1996 period identified a non-significant increase in Arizona but an average annual decline of 7.1 percent in New Mexico, with mapped trends showing declines in the western and eastern portions of the breeding range, including southern Nevada, southern California, and eastern Arizona (NatureServe 2026).

In Nevada, the species exists at the periphery of its range. Limited Breeding Bird Survey route coverage in the state precludes reliable trend estimates, but the difficulty of confirming observations and breeding attempts indicates the species is rare on the landscape, and trends are assumed to mirror range-wide declines (NDOW 2022). The Nevada population was historically estimated at fewer than 50 birds (GBBO 2010). The low population size and patchy, isolated distribution at the range periphery increase vulnerability to local extinction and inbreeding effects (England and Laudenslayer 2020).

Habitat Level Threats

The primary threat to Bendire's thrasher at the habitat level is the destruction and degradation of desert scrub habitats supporting the large shrubs, cacti, and other spinescent vegetation required for nesting and foraging. Habitat conversion through urban and suburban expansion removes structural vegetation and eliminates occupied territories (NDOW 2022; NatureServe 2026).

Wildfire poses an increasing threat in the northeastern Mojave Desert as fuel loads grow in association with invasive annual grasses, particularly cheatgrass (*Bromus tectorum*) and red brome (*Bromus madritensis*) (D'Antonio and Vitousek 1992, Brooks and Esque 2002). Fire destroys and degrades desert scrub, removing the vegetation structure required for nesting and foraging. Invasive annual grasses are further identified as a medium-level threat because they alter the natural wildfire regime, reduce native shrub density, and are correlated with reduced arthropod diversity and abundance, likely diminishing prey availability for insectivorous species such as Bendire's thrasher (NDOW 2022).

Large-scale industrial solar energy development is identified by the 2022 Nevada State Wildlife Action Plan as a medium-level threat, as utility-scale projects eliminate suitable breeding habitat in southern Nevada (NDOW 2022). Additionally, off-road vehicle use and other recreational activities that degrade desert scrub structure can reduce habitat quality by removing or damaging large shrubs and cacti necessary for nesting

(GBBO 2010). Harvesting or removal of large desert plants such as Joshua trees and other yuccas is also identified as detrimental where it alters the natural habitat structure required by the species (NatureServe 2026).

Threats to Species

Bendire's thrasher is considered especially sensitive to predation pressure because nests are built relatively low in vegetation, approximately 1 meter above the ground surface, making them accessible to subsidized predators (e.g., coyote and fox) associated with urban and suburban areas (Esque et al. 2010; Brown 1901). As urban areas expand, subsidized predators with access to food and water from garbage, gardens, golf courses, and overwatering can penetrate into adjacent desert scrub habitats, increasing nest predation rates and extending the effective influence of urban development on nesting success (Esque et al. 2010).

The small size and isolation of Nevada's Bendire's thrasher population creates additional vulnerability. Small, isolated populations are at elevated risk of inbreeding and local extinction (England and Laudenslayer 2020). The Mojave Desert population may also face interspecific competition for habitat from other thrashers, including LeConte's Thrasher and Crissal Thrasher, which occupy overlapping habitat in portions of Clark County (Nussear and Simandle 2020).

The causes of population decline are not fully understood. Ephemeral and spatially variable invertebrate prey resources may require that populations use much larger landscape areas than breeding territory size alone would suggest, complicating habitat management and conservation planning (NDOW 2022). Climate change may alter precipitation patterns and temperature regimes in ways that affect prey availability, habitat structure, and breeding phenology, though specific effects are not well characterized.

Conservation and Management

Bendire's thrasher is protected at the federal and state levels under the Migratory Bird Treaty Act. The 2022 Nevada State Wildlife Action Plan designates the species as a Species of Greatest Conservation Need and establishes a strategic vision for its conservation at the landscape level (NDOW 2022). State Wildlife Action Plan conservation actions for the species include: determining current population status in areas not previously covered by desert thrasher surveys; conducting standard randomized breeding surveys following protocols developed by the Desert Thrasher Working Group; and combining surveys with invertebrate prey sampling and measurements of climate-sensitive variables to compare occupied and unoccupied habitats within the same land cover type (NDOW 2022).

The Desert Thrasher Working Group (DTWG) has developed a standardized survey and habitat evaluation protocol for Bendire's thrasher and LeConte's thrasher that is recommended for use in Nevada and adjacent states (DTWG 2018). The protocol uses a 9-ha (300 x 300 m) area search plot with three repeat visits per season and a standardized 40-minute search period per visit. In Nevada, surveys for Bendire's thrasher are recommended from late March through June, with lower-latitude and lower-elevation plots surveyed earlier in the season. Inter-annual differences in breeding phenology may span several weeks depending on winter precipitation, and principal investigators are advised to account for recent precipitation history when scheduling surveys (DTWG 2018). Habitat evaluation at each plot includes point-center quarter measurements of vegetation density and structure, estimates of fruit-bearing shrub and yucca density, and documentation of disturbance and invasive species. The protocol has been used for range-wide surveys coordinated through BLM funding in Arizona, California, Nevada, New Mexico, and Utah (DTWG 2018).

The Nevada Comprehensive Bird Conservation Plan designates Bendire's thrasher a Conservation Priority species and recommends protecting occupied habitat from conversion, energy development, and fire;

monitoring and potentially limiting off-highway vehicle use in occupied habitat; controlling invasive weeds to reduce fire risk; inventorying and mapping important habitat; developing improved monitoring methods; and conducting studies to better estimate minimum patch size, home range, landscape mosaic use, and response to edge effects (GBBO 2010).

Partners in Flight has identified Bendire's thrasher as a Species of Continental Importance and a Watch List species for the United States and Canada (Rich et al. 2004). At the state level, Partners in Flight set an objective of doubling Nevada's population from an estimated 1,000 individuals to 2,000 individuals, with statewide population targets set at 2,046 individuals to meet continental population objectives (Rosenberg 2004).

The table below summarizes the acres of suitable habitat within the MSHCP Amendment Plan Area.

Bendire's thrasher (*Toxostoma bendirei*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	871,245	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	25,833	3.0%
Suitable Habitat in Lands Managed for Resource Conservation	527,947	60.6%
Suitable Habitat in the existing MSHCP Reserve System	235	0.0%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	115,584	13.3%

*Nussear et al. 2024

Clark County Survey Data

Avian surveys were conducted by SWCA Environmental Consultants at Clark County Desert Conservation Program properties from 2020 through 2025, covering the Riparian Reserve Units along the Virgin and Muddy Rivers and the Boulder City Conservation Easement (SWCA 2020, 2021a, 2022a, 2023, 2024, 2025). The Boulder City Conservation Easement is dominated by Mojave Desert scrub co-dominated by creosote bush and burrobush, constituting over 97 percent of the easement's vegetation community and representing potential Bendire's thrasher habitat given its association with intact upland mixed Mojave desert scrub in southern Clark County. No Bendire's thrasher detections were recorded during annual surveys within the Boulder City Conservation Easement across any of the survey years (SWCA 2020, 2021a, 2022a, 2023, 2024, 2025). The absence of detections is consistent with the species' low detectability and sparse distribution and does not preclude its presence in the Boulder City Conservation Easement or adjacent upland habitats.

County-wide avian surveys conducted by SWCA in 2021 resulted in three detections of Bendire's thrasher, all recorded during area-search surveys at a single subplot within the Highland Range site, with one detection per survey round (SWCA 2021b). All three detections likely represented a single breeding territory, with the highest observed breeding evidence being a singing bird present 7 or more days, indicating probable breeding. Given that 77 percent of survey subplots intersected predicted habitat, the low number of detections was somewhat unexpected. Dry conditions during 2020 to 2021, including a record-setting 240 consecutive days without measurable precipitation in Las Vegas between April 20 and December 17, 2020, may have contributed to lower-than-normal detection probability (National Weather Service 2021). Field observations also indicated that some predicted habitat areas lacked suitable nesting substrates such as

large cholla, yucca, or spinescent shrubs, suggesting the habitat model may overestimate the presence of Bendire's thrasher habitat in Clark County (SWCA 2021b).

County-wide avian surveys conducted by SWCA in 2022 resulted in six total detections of Bendire's thrasher: two recorded during area-search surveys and four incidental detections, all concentrated within a 220-km² area of southern Clark County near Searchlight (SWCA 2022b). Both survey detections were of non-singing individuals at different sites (New York Mountains and North Searchlight), providing no evidence of breeding. One incidental detection consisted of a pair in suitable habitat, indicating probable breeding in the area. The 2021 and 2022 survey results together are consistent with the distribution of detections used to develop the habitat suitability model, all concentrated in or near the largest patch of predicted optimal habitat at the southern end of the county. Field observations from 2022 further indicated that several surveyed subplots with predicted habitat lacked key structural components associated with occupied territories, including adequate slope, suitable elevation, and structural heterogeneity such as taller shrubs interspersed with expanses of bare ground (SWCA 2022b; Desmond and Sutton 2017). These results reinforce the conclusion that the habitat model may overestimate available habitat for this species in Clark County.

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LeConte's Thrasher (*Toxostoma lecontei*)

Photo Credit: Brian Small Photography

Species Overview

LeConte's thrasher (Toxostoma lecontei) is a medium-sized songbird and one of four desert thrasher species found in Clark County, Nevada. The others are Bendire's (*T. bendirei*), Crissal (*T. crissale*), and Sage thrasher (*Oreoscoptes montanus*). LeConte's thrasher is a permanent resident of open, arid desert habitats and is the palest of the North American thrashers, with sandy-gray plumage that blends into its desert surroundings (Sheppard 2020). It has a long, nearly black tail that contrasts with the pale gray body, and a long, strongly decurved black bill. No large differences in plumage exist between the sexes; however, seasonal variation occurs, attributed mainly to the bleaching effects of sunlight. When freshly molted in August and September, the crown and upperparts are gray to dark gray. Plumage bleaches rapidly by October and November, becoming light gray. The rump is dark gray to black, and the chin is white, bordered below by a distinct dusky or dark gray-brown malar streak (NDOW 2022). In good light, the species has dark red-brown eyes (Fisher 1893), which distinguish it from other thrasher species with yellowish eyes.

LeConte's thrasher forages primarily on the ground, using its long, strongly decurved bill to probe soil and leaf litter for invertebrates and small vertebrates. Diet includes insects, spiders, scorpions, small fruits, and seeds, and sometimes lizards and small snakes; food may be obtained in the open or removed from leaf litter or dug from the ground under shrubs (NatureServe 2023). The species is shy and secretive, preferring to run from intruders rather than fly (Fisher 1893). Its call has been described as resembling the whistle a person uses to summon a dog, short and with a rising inflection at the end (Gilman 1904). The song is heard less frequently than the call and is recognized as distinctive and melodious, similar to the mockingbird's but of higher pitch and richer quality (Gilman 1904).

LeConte's thrasher is a non-migratory species; immatures may wander up to 10 km in rare cases (NatureServe 2023). Pairs are year-round residents, with breeding typically beginning in late January to early February for the first brood. Second, third, and fourth broods are documented, with multiple clutches also documented in wetter years when primary and secondary productivity is higher (Hill 1980; Sheppard 2020). Two to five eggs are laid per brood; young fledge and depart the nest after approximately 16 days (NDOW 2022). The species is longest-lived to at least five years and eight months based on banding data, with one pair confirmed to have bred together for over four years (NDOW 2022).

Range

LeConte's thrasher is a hot desert species occurring from eastern California to extreme southwestern Utah in the United States, and south through Arizona into Sonora and Baja California, Mexico (Sheppard 2020; NatureServe 2023). The range encompasses the San Joaquin Valley and the, Colorado, Mojave, and Sonoran Deserts in California and Nevada (Sheppard 2020). There is also an isolated population along the Pacific side of central Baja California (Sheppard 2020). Elevational range extends from approximately -81 meters in Death Valley to 1,600 meters, with most occurrences between 0 and 1,150 meters (NatureServe 2023). Population size in the United States is estimated at approximately 64,000 individuals, with a broader global estimate of 190,000, though data quality for the latter is considered poor (NatureServe 2023).

In Nevada, LeConte's thrasher occurs throughout the Mojave Desert and Great Basin/Mojave desert ecotone in southeastern Nevada, primarily in Clark, Nye, Esmeralda, and Lincoln counties (Sheppard 1996; NDOW 2022). Within Nevada, the species occupies desert scrublands from sea level to 1,600 meters elevation (Floyd et al. 2007). Within Clark County, the species is most consistently detected in open desert flats, washes, and alluvial fans with scattered shrubs and sandy or alkaline soils. Large tracts of medium- and high-suitability habitat are predicted to occur in central and southern Clark County, including the Pahrump and Sandy valleys, Las Vegas Valley, Ivanpah Valley, and the area around the community of Searchlight (Nussear et al. 2024). A small breeding population was recently discovered in Lahontan Valley, approximately 200 miles north of the previously understood range boundary in Nevada, suggesting the species' range may be broader than previously documented (NDOW 2022).

Habitat Characteristics

LeConte's thrasher occupies sparsely vegetated desert flats, dunes, alluvial fans, and gently rolling hills with relatively flat topography, generally at slopes of less than 4 degrees (Sheppard 1970; Fletcher 2009). Habitat is characterized by a high proportion of one or more species of saltbush or shadscale (*Atriplex* spp.) and/or cylindrical cholla cactus (*Opuntia* spp.) 0.9 to 1.9 meters high (NatureServe 2023). Soils in occupied areas are typically silty or sandy and often alkaline. The majority of shrubs rarely exceed 2.5 meters in height, except for isolated desert trees, yuccas (*Yucca* spp.), or tall, thin shrubs such as ocotillo (*Fouquieria*) (NatureServe 2023). Accumulated leaf litter under shrubs is important as diurnal cover for arthropod prey, including scorpions, beetles, grasshoppers, spiders, Lepidoptera, larvae, and small lizards (Sheppard 1970). The species rarely occurs in habitats consisting entirely of creosotebush (*Larrea tridentata*) and has a negative association with blackbrush and pinyon-juniper communities, which are correlated with steeper slopes (Fletcher 2009). Habitat use may vary in response to annual precipitation; surveys at Tule Springs Fossil Beds National Monument in Clark County found the species using atypical, rockier Mojave Desert scrub habitat with slopes greater than 5 degrees following a winter with above-average rainfall, whereas in a drier year detections were restricted to flat saltbush-dominated stands (Simmons 2024). This suggests that survey results and apparent habitat preferences may be influenced by interannual variation in rainfall and should be interpreted accordingly.

Areas inhabited by LeConte's thrasher include saltbush (*Atriplex polycarpa* and *A. canescens*), cholla (*Opuntia echinocarpa*, *O. ramosissima*), Mojave mixed-shrub communities, and wash vegetation including mesquite (*Prosopis* spp.), smoketree (*Psorothamnus spinescens*), and catclaw acacia (*Acacia greggii*) (Dawson 1923; Fletcher 2009). The species shows a strong positive association with wash habitat, likely due to the increased presence of large thorny trees, shrubs, and cactus that provide protection from predators and ameliorate harsh conditions for nesting birds (Fletcher 2009). Zonal analysis of habitat modeling indicates that the

highest suitability habitat for this species occurs in Mojave Desert Scrub, Mesquite-Acacia, and Salt Desert Scrub ecosystems (Nussear and Simandle 2020).

Nests are typically constructed in low, dense, thorny shrubs or cholla cactus, with shade overhanging the nest site, usually between 1 and 2 meters above the ground surface (Sheppard 2020; NDOW 2022). At the Nevada National Security Site, nesting was observed almost exclusively in *Lycium andersonii* or *L. pallidum*, approximately 40 cm above the ground (Nussear and Simandle 2020). Home ranges in saltbush-cholla scrub average approximately 40 hectares, while breeding territories are considerably smaller, averaging 6 hectares, and are defended most actively from early December to early February (NatureServe 2023). Surface water is rarely present within several kilometers of occupied territories except temporarily following infrequent rains (NatureServe 2023).

Habitat Suitability Model

Habitat suitability for LeConte's thrasher in Clark County was modeled by Nussear et al. (2024) using an ensemble modeling approach incorporating General Additive Model, RF, MaxEnt, and GBM algorithms. Models were built using 605 locality records within the buffered modeling area, which were spatially thinned to 388 localities to exclude dense point aggregations. Both base environmental variable models and vegetation-augmented models were developed.

For the vegetation-augmented model, only the RF algorithm performed well enough to be included in the ensemble; however, performance metrics for this model were high across all indices. The ensemble model for the base models was comprised of 19 RF models, 3 GAM, 4 MaxEnt, and 14 GBM models. The vegetation-augmented ensemble included 20 RF models.

The most influential environmental variables across modeling algorithms were the coefficient of variation (CV) of winter precipitation and average spring maximum temperature, which were among the top contributing variables in each of the algorithms. Additional important variables included flow accumulation, slope, NDVI length of season, and CV of average spring maximum temperature. The vegetation layer contributed moderately in the vegetation-augmented RF model, reflecting the importance of shrub cover structure in defining suitable habitat. The base model had high overall performance, with an ensemble AUC of 0.94 for training data and 0.99 for testing data; ensemble TSS values were 0.73 for training and 0.90 for testing (Nussear et al. 2024).

Suitable habitat for LeConte's thrasher is predicted to be widespread in the southern and western lowland areas of Clark County. High-suitability areas are concentrated in the Pahrump and Sandy valleys, Ivanpah Valley, south of Jean Dry Lake, the valley south of Sloan Canyon, the northwestern bajada of Eldorado Valley, the vicinity of Corn Creek, and near Indian Springs. Smaller and less connected habitat patches are predicted near Mormon Mesa and Mesquite, Nevada. The model largely agrees with known range maps for the species, with Nevada representing the northern extent of the distribution; some occurrences extend toward St. George, Utah. The model predicted habitat primarily in the southern California lowlands and along the larger Colorado River drainage. Standard error for the ensemble model is relatively low (0.04 or lower) across most of Clark County, with higher error rates concentrated near the Nellis bombing range and the Nevada National Security Site, indicating overall good model fit in areas of predicted suitable habitat (Nussear et al. 2024). See Figure 13 for the habitat suitability model output for LeConte's thrasher in Clark County.

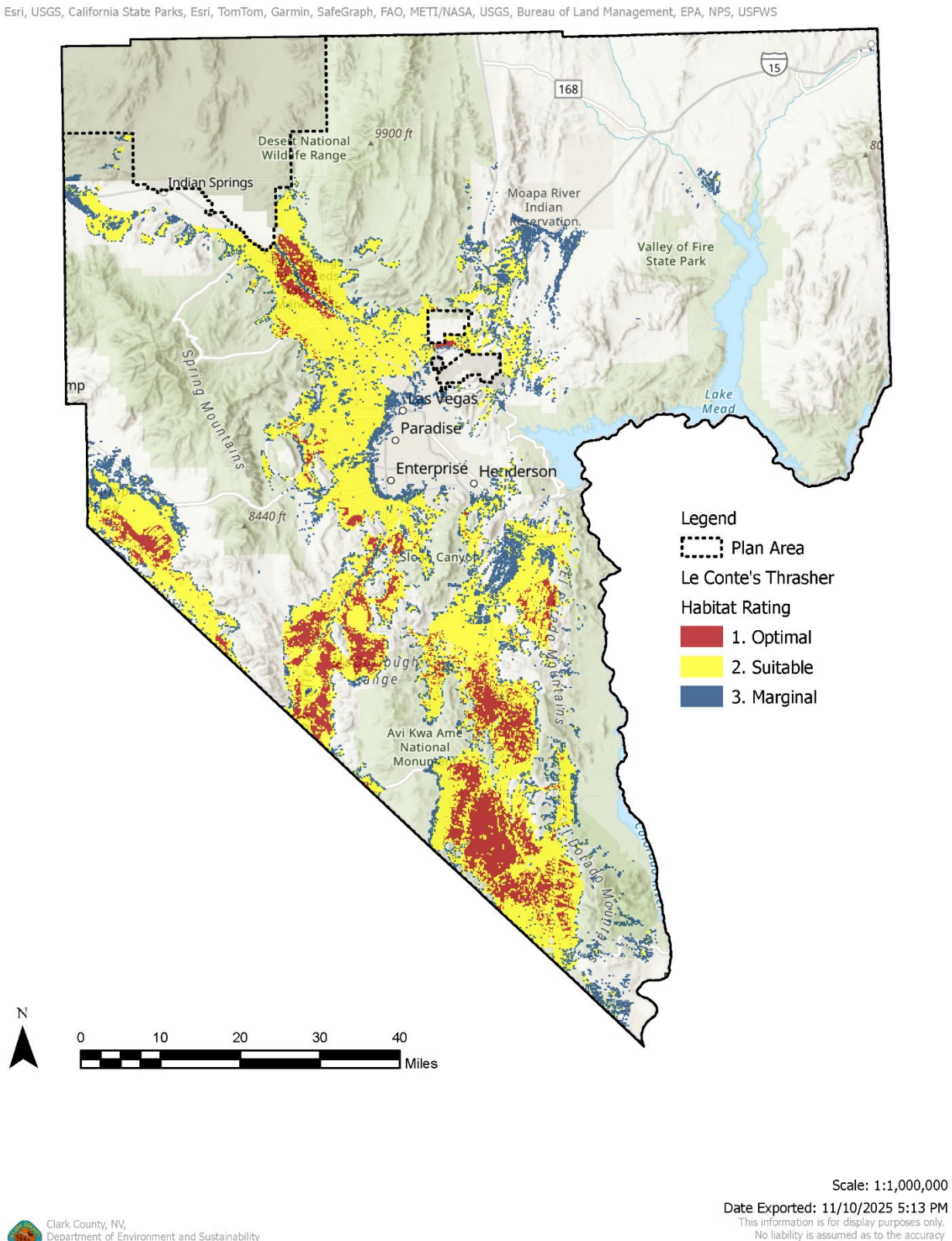

Figure 13. Habitat suitability model for LeConte's thrasher (*Toxostoma lecontei*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Evaluation
U.S. Fish and Wildlife Service Endangered Species Act	Not listed
Migratory Bird Treaty Act	Protected
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	None
State of Arizona	Species of Greatest Conservation Need
State of California	Candidate Endangered/Threatened; Species of Special Concern[1]
State of Utah	None
NV Division of Natural Heritage	At Risk
NV State Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Presumed Stable
NatureServe Global and NV State Rank	G4 S2
IUCN Red List	Least Concern
CITES	No status

[1] State designation refers only to the San Joaquin Valley population.

LeConte's thrasher is not listed under the federal Endangered Species Act. The species is protected under the Migratory Bird Treaty Act of 1918 (as amended). A petition to list the species as threatened and to designate critical habitat was received by USFWS on July 30, 2025 (USFWS 2026). At the state level, on April 16, 2026, the California Fish and Game Commission voted to designate LeConte's thrasher as a candidate species under the California Endangered Species Act in response to a petition. Candidate status confers the full protections of the Act, including the prohibition on take, while the California Department of Fish and Wildlife completes a 12- to 18-month status review and the Commission determines whether to list the species as threatened or endangered. The candidate listing applies rangewide in California, where approximately 82 percent of the global population (37,000 individuals) resides, primarily in the San Joaquin Valley, Mojave Desert, and Sonoran Desert; California also continues to designate the San Joaquin Valley population a Species of Special Concern. The species has no CITES designation and is listed by the IUCN Red List as Least Concern; however, this designation does not reflect the significant population declines documented in recent decades.

Globally, NatureServe assigns LeConte's thrasher a G4 rank (Apparently Secure), last reviewed September 1, 2023, reflecting a range extent of 200,000 to 2,500,000 square km and the existence of many occurrences on protected lands. However, NatureServe characterizes the species as declining rangewide from habitat loss due to agriculture, suburban development, oil and gas development, and overgrazing, with a global population estimated at fewer than 200,000 birds (NatureServe 2023). State rankings reflect considerably

more concern: S3 (Vulnerable) in Arizona and California, and S2 (Imperiled) in Nevada. In Nevada, the species is ranked S2 and classified as a Species of Greatest Conservation Need in the 2022 Nevada State Wildlife Action Plan (NDOW 2022). The U.S. Forest Service, Region 4 lists the species as Sensitive, and it is recognized by the BLM in Nevada as a Sensitive species.

Population Trends

LeConte's thrasher populations have declined substantially across the species' range over recent decades. Breeding Bird Survey data indicate an average annual decline of approximately 1.7 percent across the southwestern U.S. range from 1966 to 2019 (NDOW 2022). Over a longer time horizon, the species experienced an estimated 64 percent decline in desert scrub habitat within the area covered by the Sonoran Joint Venture between 1970 and 2014 (NDOW 2022). eBird trend data similarly indicate declines of 20 to 30 percent through most of the species' range (NatureServe 2023). NatureServe characterizes the short-term trend as a decline of 30 to 70 percent and the long-term trend as a decline of 30 to 50 percent. The species is designated a Red Watch List Species in North America, with an estimated continental population decline of 67 percent between 1970 and 2014 (NDOW 2022). Global population estimates range from approximately 64,000 individuals in the United States (Rosenberg et al. 2016) to a broader global estimate of 190,000, though data quality for the latter is considered poor and ongoing declines have likely reduced that figure further (NatureServe 2023).

The species is responsive to annual variation in precipitation, increasing nesting effort and productivity in wetter years with higher primary and secondary production (Gilman 1904; Hill 1980). At Rock Valley in Nye County, Nevada, LeConte's thrasher maintained breeding densities of 3 birds per 100 hectares that remained constant among years; the species was a regular breeder in that habitat and was found there year-round in desert habitat but not on higher mesas (Hayward et al. 1963). Elsewhere throughout the range, densities were estimated at zero to five birds per square mile, with higher densities in optimal habitat areas (Sheppard 1970).

In Nevada, Breeding Bird Survey routes are insufficient to adequately monitor the species within the state, limiting quantitative trend assessments at the state level (NDOW 2022). The 2022 Nevada State Wildlife Action Plan flags a recently discovered small breeding population in Lahontan Valley, approximately 200 miles north of the previously understood range boundary, as warranting a rangewide reassessment to determine the species' current distribution (NDOW 2022).

Habitat Level Threats

LeConte's thrasher inhabits Mojave Desert Scrub, Blackbrush, Salt Desert Scrub, Mesquite-Acacia, and Desert Riparian habitats, with limited habitat in pinyon-juniper and sagebrush ecosystems (Nussear and Simandle 2020). Ecosystem-level threats are consistent across the species' range in hot desert habitats and include any type of surface disturbance that destroys desert vegetation, thereby modifying or reducing cover, foraging sites, and nesting areas. Specific disturbances include industrial or urban development, military training, and off-highway vehicle use, particularly when occurring along desert washes (Nussear and Simandle 2020).

Wildfire, increasingly frequent due to the spread of invasive non-native annual plants such as red brome (*Bromus rubens*), Sahara mustard (*Brassica tournefortii*), and Arabian schismus (*Schismus arabicus*), poses a medium-level threat by removing the shrub cover the species requires (NDOW 2022). Off-highway vehicle use disturbs soil substrate and leaf litter critical to arthropod prey availability and can negatively affect habitat suitability (Bury 1977; NDOW 2022). Late-season livestock grazing may also degrade habitat suitability in occupied areas, though overall grazing pressure has declined in much of the occupied range

(NDOW 2022). Energy development and mining can fragment habitat. Climate change, persistent drought, and increasing temperature extremes are projected to degrade or eliminate suitable habitat across the species' range (NDOW 2022).

Threats to Species

The primary drivers of LeConte's thrasher population declines are habitat loss and degradation resulting from agricultural conversion, urban and suburban development, large-scale energy development, and overgrazing (NatureServe 2023; NDOW 2022). The species has demonstrated a consistent negative response to development within occupied habitat, and many local populations have been extirpated by land development projects (NDOW 2022). Any destruction of substrate, litter, or shrubs affects habitat suitability for arthropod prey and, in turn, reduces the carrying capacity for LeConte's thrasher (NDOW 2022).

LeConte's thrasher is particularly vulnerable to solar energy facility development because the species and the facilities both require the flattest landscape available. Habitat models indicate that the highest quality LeConte's thrasher habitat and the most sought-after solar development areas overlap almost entirely (Nussear and Simandle 2020).

Sensitivity to habitat fragmentation is a notable concern. The species tends toward philopatry and limited dispersal, with maximum dispersal for nearly all young of the year estimated at approximately 8 to 10 km (Sheppard 1970). Fragmentation of the open desert landscape therefore reduces connectivity among subpopulations and may increase local extinction risk. The 2022 Nevada State Wildlife Action Plan recommends protecting occupied habitat at recommended patch sizes, maintaining habitat corridors between occupied areas, and minimizing fragmentation (NDOW 2022).

Conservation and Management

LeConte's thrasher is not protected by the Endangered Species Act, and no lands are set aside specifically for this species. However, substantial portions of predicted moderate-quality habitat occur within lands administered by the NPS, BLM, USFWS, and U.S. National Forest. Specific protected areas within Clark County that include LeConte's thrasher habitat include Lake Mead National Recreation Area, Gold Butte National Monument, Desert National Wildlife Refuge, Red Rock Canyon National Conservation Area, the Wee Thump Wilderness and associated wilderness areas, Humboldt-Toiyabe National Forest, and several ACECs throughout the county (Nussear and Simandle 2020). Habitat restoration activities targeting invasive species removal are ongoing on public lands and are likely to benefit LeConte's thrasher.

The 2022 Nevada State Wildlife Action Plan designates LeConte's thrasher as a Species of Greatest Conservation Need. Conservation challenges identified by the plan include sensitivity to habitat fragmentation, degradation, or conversion from urban, agricultural, and industrial development; heavy off-highway vehicle use; wildfire; energy development; and late-season livestock grazing. The plan recommends protecting occupied habitat at adequate patch size, maintaining habitat corridors between occupied areas, minimizing habitat fragmentation, and preventing improper grazing in existing occupied habitat (NDOW 2022).

The Nevada Comprehensive Bird Conservation Plan (GBBO 2010) designates LeConte's thrasher a priority species and recommends inventorying and mapping critical habitat, improving monitoring efforts and population size and trend estimates, controlling invasive weeds to reduce fire risk, and monitoring and if necessary limiting off-highway vehicle use in occupied habitat (GBBO 2010).

The following table summarizes the acres of suitable habitat within the MSHCP Amendment Plan Area according to habitat suitability modeling by Nussear et al. (2024).

LeConte's thrasher (*Toxostoma lecontei*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	1,072,483	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	125,076	11.7%
Suitable Habitat in Lands Managed for Resource Conservation	413,676	38.6%
Suitable Habitat in the Existing MSHCP Reserve System	76,967	7.2%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	74,685	7.0%

* Nussear et al. 2024

Clark County Survey Data

Valleys throughout Clark County were surveyed at 432 random sites for the presence of LeConte's thrasher between 2005 and 2007, with positive detections at 41 of the random survey locations and 24 additional non-random incidental sites (Fletcher 2009). An occupied nest was observed on Mormon Mesa during historical surveys (Fisher 1893), but the species was not detected there during the 2009 surveys. The largest contiguous area where LeConte's thrasher was not detected was most of Gold Butte and the Virgin River Valley, a contrast to late 1800s observations when the species was reported in the Virgin River Valley, suggesting possible population loss in that area (Fisher 1893; Fletcher 2009). Fletcher (2009) predicted high-quality habitat suitability in the Pahrump and Sandy valleys, Ivanpah Valley, south of Jean Dry Lake, the valley south of Sloan Canyon, the northwestern bajada of Eldorado Valley, the vicinity of Corn Creek, and near Indian Springs.

Targeted surveys for LeConte's thrasher were conducted at Tule Springs Fossil Beds National Monument in the Las Vegas Valley in 2021 and 2022 using the area-search protocol developed by the DTWG. Surveys were conducted across 33 plots (each 90,000 m^2) within the monument. During 2021, following an exceptionally dry winter in which precipitation for December through February totaled zero millimeters compared to the three-month average of 12.95 mm, LeConte's thrashers were detected exclusively in uniform stands of cattle saltbush (*Atriplex polycarpa*) on flat terrain, and no thrashers were observed in the rockier, more topographically diverse Mojave Desert scrub plots within the monument. In 2022, following a winter with 35.05 mm of precipitation (approximately 2.7 times the average), multiple LeConte's thrashers, including at least one nesting pair, were detected in Mojave Desert scrub habitat on a rockier substrate and more sloped terrain where they had been absent the prior year. In 2023, breeding was reconfirmed in the Mojave Desert scrub plot, with recently fledged young observed in June. These observations suggest that LeConte's thrasher habitat use in the Las Vegas Valley may vary in response to annual fluctuations in rainfall, and that the species may expand into atypical habitat in wetter years (Simmons 2024). The findings underscore the importance of considering annual variation when interpreting survey results and highlight the risk of relying solely on citizen-science data from easily accessible saltbush stands when making management decisions for the species (Simmons 2024).

Annual avian surveys conducted in the Boulder City Conservation Easement have detected LeConte's thrasher consistently since 2018 (SWCA 2025). During 2020 point-count surveys, biologists recorded 13 LeConte's thrasher detections at 11 of 20 point-count locations within the Boulder City Conservation

Easement, making it the most widely distributed MSHCP evaluation species detected at that site (SWCA 2020). Although breeding could not be confirmed during point-count surveys, biologists incidentally located multiple active nests, confirming breeding at the Boulder City Conservation Easement for the second consecutive year (SWCA 2020). During 2021 surveys at the Boulder City Conservation Easement, the species was recorded twice from a single point-count location; breeding could not be confirmed during surveys, though the species is known to breed at the site based on active nests documented in prior years (SWCA 2021a). During 2025 surveys at the Boulder City Conservation Easement, LeConte's thrasher was detected from two point-count locations, though both detections occurred outside 100 meters of a point-count location and breeding could not be confirmed (SWCA 2025). The Boulder City Conservation Easement encompasses Mojave Desert scrub habitat co-dominated by creosote bush and burrobush, with areas of salt desert scrub, dense cholla, and desert wash habitat providing suitable foraging and nesting conditions for the species.

In 2021, SWCA conducted countywide area-search surveys at 30 randomly selected sites in Clark County specifically targeting LeConte's thrasher and six other species (SWCA 2021b). Surveyors recorded 49 total detections across 16 subplots at 11 sites, including 26 detections during area searches and 23 incidental detections. All 49 detections fell within predicted habitat, with 34 in habitat modeled as optimal and 15 in habitat modeled as suitable. Four detections were recorded within proposed MSHCP Amendment Impact Areas and four within the Reserve System, all within the Boulder City Conservation Easement. The highest observed breeding evidence was a family group recorded in optimal modeled habitat, confirming breeding activity in Clark County (SWCA 2021b).

In 2022, SWCA conducted countywide area-search surveys at 30 sites in Clark County (SWCA 2022). Although no sites were specifically selected for LeConte's thrasher in 2022, 78 percent of the total surveyed area (442 hectares across 62 subplots) fell within predicted habitat. Surveyors recorded 16 LeConte's thrasher detections, with seven during area searches and nine incidental. Detections were associated with only 2 percent (11 hectares) of surveyed predicted habitat, a pattern likely influenced by the prolonged drought affecting Clark County during that period, which may have reduced breeding activity and detection probability. Breeding was confirmed elsewhere in the county through an individual observed carrying food and an active nest with young (SWCA 2022).

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Bell's Vireo (*Vireo bellii*)

Photo Credit: Brian Small Photography

Photo Credit: Sarah Nichols, SWCA

Species Overview

Bell's vireo is a small migratory songbird belonging to the family Vireonidae. It breeds across the central and southwestern United States and winters in Mexico and Central America. The species is approximately 12 centimeters in length and weighs approximately 9 grams (NatureServe 2026a). It has short, round wings, a short, straight, blunt-tipped bill, and generally drab gray to gray-green plumage. The white to yellow breast is unmarked, and the bird shows two pale wing bars, with the lower bar more prominent, and a white eye ring (NDOW 2022).

Four subspecies are recognized, each occupying distinct portions of the breeding range. The Least Bell's vireo (*V. b. pusillus*) breeds in central and southwestern California south to Baja California and is listed as Endangered under both the federal Endangered Species Act and the California Endangered Species Act (NatureServe 2026a). The Arizona Bell's vireo (*V. b. arizonae*) breeds from southeastern California to southwestern New Mexico south to Sonora and Chihuahua, Mexico (NatureServe 2026a). The two remaining subspecies, *V. b. bellii* and *V. b. medius*, occur farther east. The only Bell's vireo subspecies documented in southern Nevada is the Arizona Bell's vireo.

Bell's vireo is a long-distance migrant. Breeding populations depart the United States in late summer to fall, wintering primarily in thornscrub and riparian gallery forests along the Pacific coast of Mexico south to Honduras (NatureServe 2026a). Spring migrants typically return in early to mid-March, reaching the northern limits of the breeding range in May (NatureServe 2026a).

In Nevada, the species arrives on territories as early as mid-March, with males arriving one to two weeks before females, and typically departs by late August or early September (NDOW 2022). Nesting in Clark County typically begins in late March to April. Nests are cup-shaped structures loosely suspended from thin, forked branches, constructed with grasses, bark, plant fibers, spider webs, and hair, and lined with fine grasses and hairs (NatureServe 2026a). Most nests are located 0.5 to 1.5 meters above ground, though the range extends from 0.2 to 8.0 meters. Clutch size is three to five eggs, with four being most common, and incubation lasts approximately 14 days. Young are brooded by both parents and fledge at 10 to 12 days (NatureServe 2026a; NDOW 2022). Unsuccessful pairs will re-nest up to seven times per season (NDOW 2022). The oldest known individual was nine years old, though three to four years is a more typical lifespan (NDOW 2022). Territory size ranges from approximately 0.2 to 1.7 hectares (NatureServe 2026a). Observed

nesting densities vary widely, from 0.5 breeding pairs per 40 hectares of mesquite bosque habitat in portions of the lower Colorado River Valley to 26 pairs per 40 hectares in willow-tamarisk habitat in Arizona (NatureServe 2026a).

The species is primarily insectivorous, foraging on insects and small spiders, and occasionally fruits. Foraging occurs within dense brush, primarily within 4 meters of the ground, using gleaning, hovering, and hawking techniques (NatureServe 2026a).

Range

The breeding range of Bell's vireo (*Vireo bellii*) extends throughout the central and southwestern United States and south through northern Mexico, encompassing a broad geographic area from southern California, southern Nevada, southwestern Utah, and Arizona in the west, east to the Great Plains and portions of the upper Midwest, and south to northern Baja California, Sonora, Tamaulipas, and into Central America during the nonbreeding season (NatureServe 2026a). The species winters primarily from southern Baja California and southern Sonora south to Honduras along the Pacific slope (NatureServe 2026a).

The Arizona Bell's vireo (*V. b. arizonae*) breeds in Arizona, California, Nevada, New Mexico, and possibly Utah, associated with the Colorado River drainage, and extends into Sonora and Chihuahua, Mexico, in winter (Franzreb 1989; NatureServe 2026b). The subspecies has expanded its range northward along the Colorado River during the twentieth century, including a breeding range expansion of at least 219 kilometers along the river through the Grand Canyon over an 11-year period following habitat creation associated with flood control operations at Glen Canyon Dam (NatureServe 2026a). Populations in California have declined substantially, and this subspecies has nearly disappeared from that state (NatureServe 2026a).

In Nevada, Bell's vireo occurs almost exclusively in riparian areas of southern Nevada, with the strongest populations concentrated in wildlife refuges and other protected areas (NDOW 2022). Within Clark County, the species is concentrated in the southern tip of the county along the Colorado River, with additional populations found along the Virgin and Muddy rivers, around isolated springs, and along Lake Mead (Floyd et al. 2007; GBBO 2009).

Habitat Characteristics

The Arizona Bell's vireo is concentrated in riparian areas within the Mojave Desert, particularly in areas with low, shrubby vegetation characteristic of early successional stages. The species is particularly associated with habitats adjacent to surface water, rather than riparian vegetation growing away from surface water; direct access to surface water may be an important habitat component in Nevada (Barlow 1962; GBBO 2010 cited in NDOW 2022). In winter, the species inhabits coastal scrublands and riparian woodlands in Mexico and Central America (NDOW 2022).

Breeding habitat throughout the range is characterized by a dense shrub layer averaging 0.6 to 3.0 meters above ground, which is the most critical structural component of nesting habitat (NatureServe 2026a). Over 60 species of nest substrate plants have been documented, including willows (*Salix* spp.), mesquite (*Prosopis* spp.), rose (*Rosa* spp.), oak (*Quercus* spp.), and cottonwood (*Populus* spp.) (NatureServe 2026a). In some Arizona locations, a substantial proportion of nests have been found in tamarisk (*Tamarix ramosissima*), though the species is generally considered to avoid tamarisk in portions of its range (NatureServe 2026a; Serena 1986). In Nevada, the species will nest in tamarisk trees where other vegetation is absent (NDOW 2022).

Survey data from Clark County confirm that occupancy is most strongly associated with desert riparian corridors along the Colorado, Virgin, and Muddy rivers, with scattered occurrences in isolated mesquite bosques and desert washes (SWCA 2022a, 2022b).

Habitat Suitability Model

Habitat suitability for Arizona Bell's vireo was modeled by Nussear et al. (2024) using an ensemble modeling approach that incorporated updated occurrence records and environmental predictor layers. The updated model included seven predictor variables: average maximum temperature, average spring maximum temperature, normalized difference vegetation index (NDVI) amplitude, winter precipitation, slope, topographic position index, and soil silt content (Nussear et al. 2024). Model performance was high across all algorithms, with ensemble model area under the receiver operating curve, BI, and true skill statistic values of 0.97 to 1.00 for training data and 0.96 to 0.97 for testing data (Nussear et al. 2024).

Nussear et al. (2024) also evaluated the effect of including a vegetation layer in model predictions for this species. Models that incorporated the vegetation layer produced a substantially reduced area of predicted habitat relative to models using base environmental layers alone, with predicted habitat more tightly restricted to riparian areas around Lake Mead and upland habitat near the Spring Range (Nussear et al. 2024). Among the input variables, spring maximum temperature and soil silt content were consistently among the most influential predictors across modeling algorithms, with vegetation productivity (NDVI amplitude) and topographic position also contributing substantially (Nussear et al. 2024).

Areas of medium- and high-suitability habitat are predicted to occur in central Clark County, including the Las Vegas Valley, Muddy River drainage, Virgin River drainage, and lower Colorado River drainages (Nussear et al. 2024). The ensemble model identifies the highest-suitability habitat concentrated along riparian corridors associated with these drainages and the shorelines of Lake Mead, with lower suitability habitat extending into lower bajada areas and portions of the Las Vegas metropolitan area (Nussear et al. 2024). See Figure 14 for the Bell's vireo habitat suitability model for Clark County.

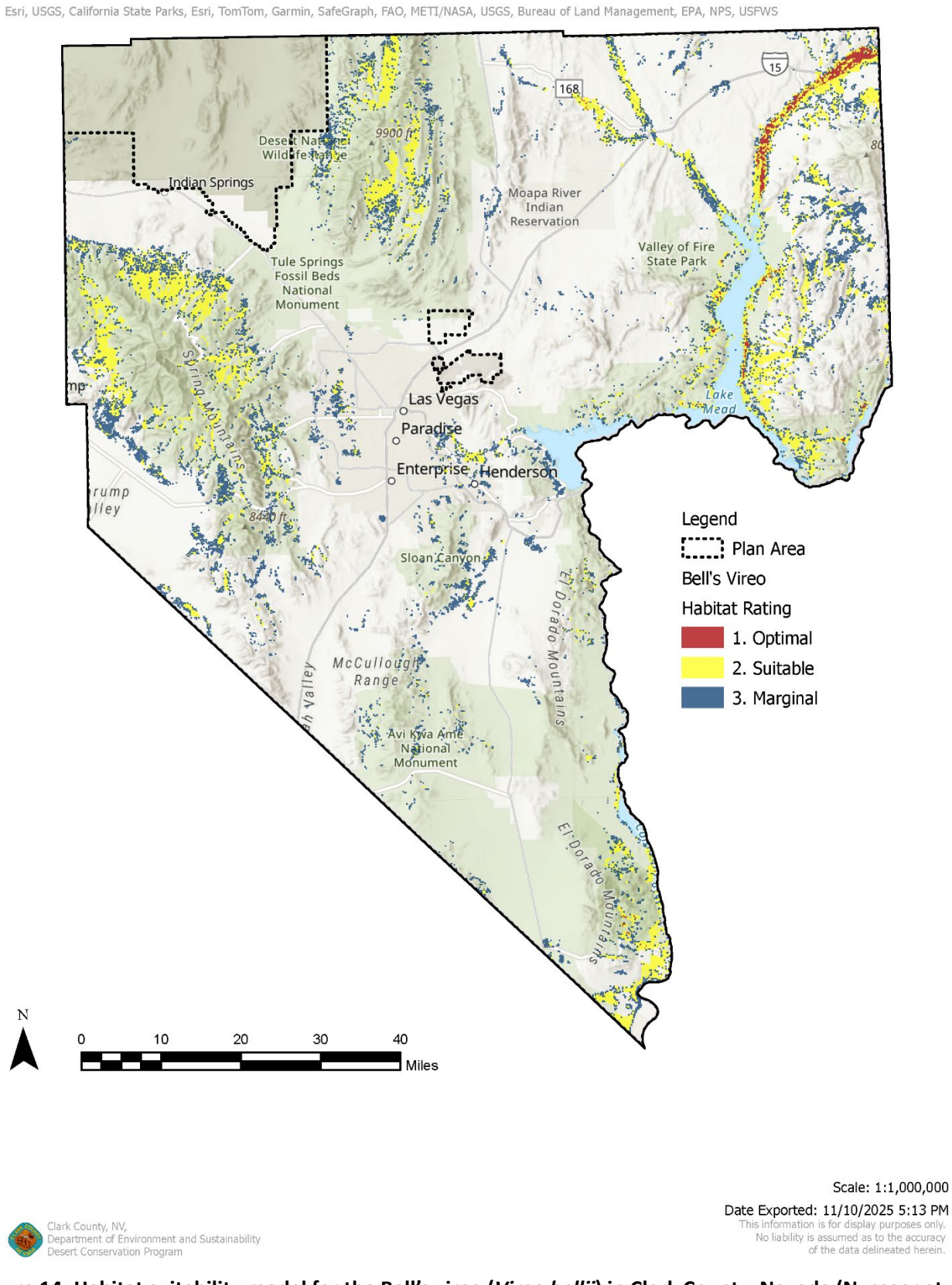

Figure 14. Habitat suitability model for the Bell's vireo (*Vireo bellii*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Covered[1]
U.S. Fish and Wildlife Service Endangered Species Act	Not Listed
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	No Status
Migratory Bird Treaty Act	Protected
State of Nevada	No Status
State of Arizona	None
State of California	State Endangered
State of Utah	No Status
NV Division of Natural Heritage	Watch List
NV State Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Presumed Stable
NatureServe Global and NV State Rank	G5T4 S2B
IUCN Red List	Least Concern[1]
CITES	No Status

[1] Status designation is for the full species Bell's vireo (*Vireo bellii*) and does not indicate subspecies status.

Bell's Vireo

Bell's vireo is ranked G5 (Secure) globally by NatureServe, reflecting a wide breeding distribution across central and southwestern North America (NatureServe 2026a). Despite its globally secure rank, Bell's vireo has experienced significant population declines across portions of its range, particularly in the arid West. North American Breeding Bird Survey data from 1966 to 1995 indicated survey-wide declines averaging 3.2 percent per year across 238 survey routes, with the steepest regional declines in the Breeding Bird Survey Central region at 4.8 percent per year (NatureServe 2026a). More recent Breeding Bird Survey data (1966 to 2019) show a nonsignificant annual increase of 1.6 percent in the Sonoran and Mojave deserts, but a declining trend of 1.3 percent per year from 1993 to 2019 (NDOW 2022). Several populations have been reduced or extirpated (NatureServe 2026a). The species has been largely eliminated from the Central Valley of California, which has lost approximately 95 percent of its riparian vegetation to agriculture and other anthropogenic factors (NatureServe 2026a). In Nevada, the species is ranked S2B (Imperiled, breeding), reflecting restricted distribution and vulnerability at the state level (NatureServe 2026a; NatureServe 2026b).

Arizona Bell's Vireo

The Arizona Bell's vireo (*V. b. arizonae*) was petitioned for federal Endangered Species Act listing in 1979 and was identified as a Candidate Category 3C in 1982, defined as taxa that are more abundant or widespread than previously believed and not subject to any identifiable threat (USFWS 1982). Listing of the Arizona Bell's vireo was determined to be "not warranted" in 1984 (USFWS 1984).

The Arizona Bell's vireo is ranked G5T4 (Apparently Secure subspecies of a Secure species) by NatureServe, with a rounded global status of T4 (NatureServe 2026b). Its U.S. range includes Arizona, California, Nevada, and New Mexico, and it inhabits the Colorado River drainage, breeding in shrubby riparian habitat (NatureServe 2026b; USFWS 2026a). The subspecies is not listed under the federal Endangered Species Act, though it was designated Endangered by the State of California in 1988 (NatureServe 2026a).

In Nevada, *V. b. arizonae* is ranked S2B (Imperiled, breeding) and is considered to be moderately declining (NDOW 2022; NatureServe 2026b). The Climate Change Vulnerability Index rating for the subspecies in Nevada is Presumed Stable (NDOW 2022).

Population Trends

Bell's vireo populations have declined significantly across portions of its range since at least the mid-twentieth century. The total population is estimated at approximately 1,500,000 individuals (Nussear and Simandle 2020). As noted in the Species Status section above, North American Breeding Bird Survey data document survey-wide declines averaging 3.2 percent per year from 1966 to 1995, a nonsignificant positive trend of 1.6 percent per year in the Sonoran and Mojave deserts from 1966 to 2019, and a declining trend of 1.3 percent per year in the more recent 1993 to 2019 interval (NatureServe 2026a; NDOW 2022). The USFWS notes that Bell's vireo populations continue to decline throughout the species' range, with riparian habitat degradation as a primary driver (USFWS 2026b).

Trend information for *V. b. arizonae* is mixed. Populations in Arizona and northern Mexico are considered fairly stable overall (NatureServe 2026a). The subspecies has nearly disappeared from California, where 35 singing males were recorded in 1981 compared to only 4 by 1986 (NatureServe 2026a). In contrast, populations along the Colorado River through the Grand Canyon expanded substantially following habitat creation associated with flood control operations at Glen Canyon Dam; territorial males increased from 67 to 136 over six years, and the breeding range expanded by at least 219 kilometers over 11 years (NatureServe 2026a).

In Nevada, Breeding Bird Survey data are insufficient to determine a statistically significant statewide trend for this subspecies, though the broader Sonoran and Mojave Desert Breeding Bird Survey region shows a nonsignificant increase from 1966 to 2019 and a slight decline from 1993 to 2019 (NDOW 2022). GBBO data indicate Bell's vireo population declines in most regions, though this trend was not confirmed for Nevada specifically (Nussear and Simandle 2020).

Management programs that combine brown-headed cowbird (*Molothrus ater*) control with riparian habitat restoration have produced localized population recoveries. One California population increased from 19 to 122 breeding vireos over eight years following cowbird removal, and a management program at Camp Pendleton grew territories from 15 in 1980 to 259 in 1991 (NatureServe 2026a).

Habitat Level Threats

The primary threats to Bell's vireo habitat include urban and suburban development on floodplains and riparian areas, water diversion, flood control projects, altered flow regimes, improper livestock grazing, spread of invasive vegetation, and fire (NDOW 2022; NatureServe 2026a). Urban development and the spread of agriculture have destroyed much of the species' western nesting habitat; the Central Valley of California, for example, has lost approximately 95 percent of its historical riparian vegetation to these factors, resulting in extirpation of the species from that region (NatureServe 2026a).

Invasive vegetation, particularly tamarisk (*Tamarix* spp.), poses a complex threat. While tamarisk is generally considered inferior nesting habitat, Bell's vireo will use it when native vegetation is absent or degraded. Active removal of tamarisk without concurrent restoration of native vegetation can result in loss of existing nesting habitat (NDOW 2022). The spread of the tamarisk beetle and the die-off of screwbean mesquite (*Prosopis pubescens*) are emerging threats to nesting habitat in Nevada (NDOW 2022). Overgrazing suppresses shrub growth and reduces nest site availability and vireo density (NatureServe 2026a).

Alterations to water flow from dam operations and water diversions affect riparian vegetation communities and can reduce the extent and quality of suitable nesting habitat. Bank channelization can result in loss of woody vegetation along watercourses (NDOW 2022). The desiccation and degradation of riparian areas in southern Nevada is an ongoing concern requiring continued monitoring (NDOW 2022).

Increased fire frequency in riparian areas can also negatively impact local breeding and foraging habitat (NDOW 2022). Off-road vehicular activity in desert washes and riparian areas represents an additional source of habitat disturbance (Nussear and Simandle 2020).

Threats to Species

Brood parasitism by brown-headed cowbird (*Molothrus ater*) is a significant driver of Bell's vireo population decline in many areas. Observed parasitism rates range from 6 percent in the Grand Canyon to 69 percent in Kansas (NatureServe 2026a). Modeling based on Least Bell's vireo populations suggests that parasitism rates exceeding 30 percent can lead to unstable populations vulnerable to extirpation by stochastic events, while rates of 48 percent and 69 percent could lead to population extinction within 18 and 8 years, respectively (NatureServe 2026a). While nest abandonment was once considered a compensating mechanism, research indicates that abandonment results in lower fitness relative to birds that raise parasitic cowbird chicks (Kus 2002 cited in Nussear and Simandle 2020).

The Arizona Bell's vireo subspecies may be partially buffered from cowbird parasitism due to phenological differences in nesting initiation. In Arizona, *V. b. arizonae* initiates nesting in early April before cowbirds become common in the area, whereas the Least Bell's vireo initiates nesting during a later period that coincides more closely with cowbird seasonal arrival; this reduces the relative rate of brood parasitism experienced by the earlier-nesting subspecies (NatureServe 2026a). The extent of cowbird parasitism in Nevada is not well characterized, and further research is needed to clarify the threat level for this subspecies in Clark County (NDOW 2022).

Predation is also a source of nest failure for Bell's vireo. Because nests are frequently near the ground, brooding adults and young are susceptible to predation by domestic cats, raccoons, opossums, coyotes, weasels, woodrats, deer mice, rats, and various snake species, as well as avian predators including greater roadrunner, American crow, and scrub jay (NatureServe 2026a).

Feral cats represent an elevated predation risk for Bell's vireo in proximity to developed areas (NDOW 2022). Population isolation and inbreeding depression may affect small, fragmented populations; at least one isolated population with otherwise low parasitism rates and intact habitat has experienced decline potentially attributed to inbreeding (NatureServe 2026a).

Conservation and Management

Bell's vireo is protected under the Migratory Bird Treaty Act of 1918 as amended. The Arizona Bell's vireo is also covered under the Lower Colorado River Multi-Species Conservation Program, the goal of which is to conserve habitat of threatened and endangered species, reduce the likelihood of additional species listings,

accommodate present water diversions and power production, and provide the basis for incidental take authorizations (Nussear and Simandle 2020). The species is included in the Partners in Flight North American Landbird Conservation Plan as a Watch List species, is on the USFWS List of Birds of Conservation Concern, and has been included in the GBBO's inventory and monitoring program on land birds of Clark County (Nussear and Simandle 2020).

Recommended conservation actions specific to Bell's vireo in Nevada are included in the Nevada Wildlife Action Plan (NDOW 2022) and include: preserving mesquite bosques through private landowner consultation and responsive development planning; conserving habitat by expanding protected status for occupied riparian areas; increasing the linear extent of multi-storied native riparian habitat on floodplains; maintaining habitat at its current distribution in stable or increasing condition; and sustaining stable or increasing populations of wildlife in key habitats (NDOW 2022).

Conservation programs combining brown-headed cowbird control with riparian habitat restoration have produced localized recoveries in other portions of the species' range and represent viable management tools for Clark County populations (NatureServe 2026a; NDOW 2022). Cowbird control, relocation of livestock facilities away from riparian areas, and reduction of grazing in riparian areas to maintain a dense understory are recommended management actions (NatureServe 2026a). Preservation of existing habitat and controlled releases of water from dams to sustain mesic riparian habitat are also important conservation measures for Nevada populations (NDOW 2022).

Arizona Bell's vireo (*Vireo bellii arizonae*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	441,694	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	20,920	4.7%
Suitable Habitat in Lands Managed for Resource Conservation	307,632	69.6%
Suitable Habitat in the existing MSHCP Reserve System	4,314	1.0%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	20,541	4.7%

* Nussear et al. 2024

Clark County Survey Data

Because this subspecies occupies a relatively small geographic range within Nevada and Clark County, concentrated in desert riparian corridors, survey effort is constrained by habitat availability and access. Detection can be challenging during migration periods when transient individuals may be confused with territorial breeders; behavioral observations are necessary to distinguish migrant from breeding birds.

Surveys conducted by SWCA from 2016 through 2025 have documented Arizona Bell's vireo occurrences concentrated along riparian corridors and desert washes, including the Virgin and Muddy rivers in the northeastern portion of the county, the southern tip of the county between the Newberry Mountains and the Colorado River, the Las Vegas Wash, and scattered mesquite bosques north and west of Las Vegas. Nearly two-thirds of all detections have occurred in desert riparian habitat along the Virgin and Muddy river drainages (SWCA 2022a, 2024, 2025).

Point-count surveys on Clark County MSHCP Riparian Reserve Units in 2020 recorded Arizona Bell's vireo at all five subunits (Mesquite West, Bunkerville, Riverside, Mormon Mesa, and Muddy River), with a combined

total of 39 detections. The species was the most abundantly detected MSHCP-covered bird at the Riverside Subunit, where it was the third-most detected species overall, indicating use of a wide range of riparian and scrub habitats including screwbean mesquite and tamarisk in addition to willow (SWCA 2020).

In 2021, SWCA conducted area-search surveys at 30 randomly selected sites across Clark County as part of a broader avian survey effort to refine habitat suitability models (SWCA 2021b). Surveyors recorded one detection during formal area searches and 11 incidental detections across one site and one subplot. All detections but one were within predicted habitat modeled as optimal or suitable; the single off-model detection was 318 meters from the nearest predicted habitat boundary. All detections were associated with riparian vegetation adjacent to the Virgin River, lower Las Vegas Wash, or the lower Colorado River. The sole area-search detection was recorded at the northern Mohave Valley subplot, within 300 meters of the Colorado River in habitat with a dense shrub layer of tamarisk and mesquite, the only survey site with vegetation structure consistent with Bell's vireo breeding requirements. The highest observed breeding evidence was a singing bird present seven or more days within an existing Riparian Reserve Unit in habitat modeled as optimal, indicating probable breeding.

The 2021 surveys found that key habitat requirements were absent from 27 of 30 survey sites. Although 37 percent of subplots intersected modeled suitable habitat, field observations indicated that the initial habitat model overestimated the species' presence in Clark County, with predicted suitable habitat occurring in ecosystems not used by Bell's vireo for breeding (e.g., Mojave desert scrub, blackbrush, pinyon juniper, sagebrush) and at elevations above 1,300 meters, beyond the species' typical breeding elevation. SWCA recommended that species-specific presence/absence surveys with behavioral observations would be needed to increase the detection database and refine the model (SWCA 2021b).

In 2022, SWCA conducted follow-up area-search surveys at 30 sites across Clark County, with nine sites specifically selected to target the species (SWCA 2022b). Surveys focused on potential habitat fragments away from the three main rivers in the county. Surveyors recorded 32 detections during area searches and eight incidental detections, for a total of 40 detections across three sites accounting for 30 of those detections. All 39 in-county detections were within predicted habitat, with 79 percent in predicted suitable habitat and 13 percent in predicted optimal habitat. Of the area surveyed in 2022, 29 percent (163 hectares across 26 subplots) was predicted Arizona Bell's vireo habitat; of that surveyed predicted habitat, only 4 percent (6 hectares) was associated with detections.

Occupied territories were documented at the Meadow Valley Wash site, which contained the most extensive desert riparian habitat of any site surveyed in 2022. Detections were recorded on all three survey visits, with up to 17 detections during a single visit. Detection patterns at both subplots indicated probable breeding behavior (singing birds present seven or more days; multiple singing birds), and one detection at the southern end of the site was greater than 2.5 kilometers from any existing detection in the model input dataset, providing a new occurrence record. Single detections of migrant individuals were recorded at two additional sites (Wheeler Camp Spring and Creeks), verifying existing occurrence records. Survey results indicate that Arizona Bell's vireo uses smaller, more isolated, and more fragmented habitat patches in Clark County for migration than for breeding, and some marginal habitat misclassification was identified (SWCA 2022b).

In 2025, point-count surveys continued to detect Arizona Bell's vireo at multiple Riparian Reserve subunits, including Bunkerville East, Riverside, Mormon Mesa South, and Muddy River, with breeding code "possible" (PO) recorded at all subunits where the species was detected, indicating singing individuals in appropriate habitat during the breeding season (SWCA 2025).

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Species Accounts
Reptiles

Desert Tortoise (*Gopherus agassizii*)

Photo Credit: Kimberley Goodwin, Clark County

Photo Credit: Katrina Smith, Springs Preserve

Species Overview

The Mojave desert tortoise (*Gopherus agassizii*) is a large, long-lived, terrestrial reptile native to the Mojave and Colorado deserts of the southwestern United States. Adults can reach a length of 25 to 38 centimeters and weigh up to 7 kilograms. The shell is dome-shaped and coated in brown-grey scutes. Front limbs are large, scale-coated, and equipped with sharp claws for digging. Males are slightly larger than females and have a more pronounced gular horn (NDOW 2022). Tortoises are herbivores, foraging primarily on native winter and summer annual plants, perennial grasses, cacti, and other vegetation. Consumption of non-native grasses such as brome can cause health problems.

Desert tortoises are long-lived and take 13 to 20 years to reach sexual maturity, with a mean age at maturity of approximately 14 to 15 years depending on geographic location (Germano 1994; NatureServe 2025). Juveniles grow more rapidly than adults, with mean annual increases in shell length of approximately 10 to 11 millimeters per year, after which growth slows substantially; growth is relatively rapid for 18 to 22 years before decreasing greatly (Germano 1994). Maximum lifespan exceeds 50 years in the wild, though adults often survive only 20 to 25 years of adulthood. Annual adult survivorship is high (approximately 0.98), but survivorship from hatchling to adult averages less than 5 percent for healthy populations (USFWS 1994; NatureServe 2025). These life history traits, including low juvenile survival and slow population growth rates, make the species highly vulnerable to external threats.

Tortoises are largely subterranean when inactive, spending approximately 95 to 98 percent of their total life span in underground burrows (NDOW 2022; NatureServe 2025). They brumate during winter and emerge in spring when temperatures rise. Peak surface activity occurs when body temperatures are between 78 and 93 degrees Fahrenheit (26 and 34 degrees Celsius). Desert tortoises use multiple burrow types, each serving different functions across seasons. Summer burrows are self-excavated subterranean shelters, typically one to eight feet long with openings most often oriented to the north and placed under shrubs; in the Mojave Desert, creosote bushes provide cover for 58.5 to 77.2 percent of burrow apertures, with bursage accounting for another 21 percent (NatureServe 2025). Winter dens are more extensive, up to 30 feet long, often excavated beneath caliche or sandstone shelves along wash banks, and are commonly shared by multiple individuals, with up to 17 tortoises documented using a single den. Pallets, which are shallow excavations that barely cover the tortoise, provide common summer shelters throughout the range (NatureServe 2025).

Multiple burrow use is typical: in southern Nevada, individuals used an average of nine different burrows, and 35 percent of these were also used by other tortoises (NatureServe 2025). Tortoise burrows are also used by a wide range of co-occurring species, including kit fox, burrowing owl, Gambel's quail, desert iguana, gopher snake, coachwhip, sidewinder, and various invertebrates (NatureServe 2025).

Home ranges, rather than defended territories, characterize the behavioral ecology of desert tortoises. In southern Nevada, home ranges varied from 6 to 46 hectares, and home ranges of desert tortoises in Utah averaged 3.7 to 12 hectares, with a lifetime home range estimate of approximately 180 hectares (NatureServe 2025). Male home ranges average about twice the size of female home ranges, though individual and seasonal variation is considerable.

Access to mates is governed by male-to-male dominance hierarchies and by selective female receptivity, with a subset of adult males accounting for most mating (NatureServe 2025). Egg laying occurs mainly from May to early July, and double clutching is common in the Mojave Desert following a wet year, with the second clutch following the first by approximately one month (NatureServe 2025). Hatchlings appear after 90 to 120 days. Females can store sperm from multiple partners for five years or more. Sex determination is temperature dependent, with a pivotal temperature of approximately 31.8 degrees Celsius in Nevada populations; mostly males are produced at lower incubation temperatures and mostly females at higher temperatures (NatureServe 2025).

In 2011, the Mojave population was elevated to full species status as *Gopherus agassizii*, while most tortoises east of the Colorado River were recognized as *Gopherus morafkai*, the Sonoran desert tortoise (Murphy et al. 2011). In Clark County, all wild tortoises are considered Mojave desert tortoises and are afforded full protection under the Endangered Species Act.

Range

The range of the desert tortoise extends from Inyo County, California (north to Death Valley National Park and approximately 10 miles south of Lone Pine), through southern Nevada (Clark, Nye, and Lincoln counties, north to Yucca Mountain and Coyote Springs), and into extreme southwestern Utah (Washington County: Beaver Dam Slope and north St. George), south throughout most of the Mojave Desert to the eastern Colorado Desert of Kern, San Bernardino, Riverside, and Imperial Counties, California (Murphy et al. 2011). Recent records also document naturally reproducing populations more than 60 km south of Palm Springs, in the vicinity of Anza Borrego Desert State Park (USFWS 2022). The elevational range is mainly below 1,677 meters (5,500 feet) but extends from below sea level in Death Valley to 2,225 meters (7,300 feet) (USFWS 2011; NatureServe 2025).

In Nevada, the desert tortoise occurs across Clark, Nye, and Lincoln counties in the southern portion of the state where the Mojave Desert ecotype is found and ground temperatures exceed 15 degrees Celsius during winter (NDOW 2022). Clark County contains portions of the Eastern Mojave and Northeastern Mojave Recovery Units, making it a key component of overall species survival and recovery. Approximately 955,953 acres of formally designated desert tortoise critical habitat occur in Clark County, representing approximately 14.5 percent of the species' range-wide total of critical habitat.

Range-wide, the NatureServe range extent for the species is estimated at 20,000 to 200,000 square kilometers, and the area of occupancy based on GBIF records from 2005 to 2025 is approximately 7,216 square kilometers, or 1,804 four-square-kilometer grid cells (NatureServe 2025). Landscape features affect distribution and dispersal within this range, and gene flow among populations is at least partially restricted by large topographic features such as the Spring Mountains, New York Mountains, and Providence

Mountains, as well as by very low-elevation regions such as Death Valley and Cadiz Valley (NatureServe 2025).

Habitat Characteristics

Desert tortoises are almost entirely confined to warm creosote bush (*Larrea tridentata*) scrub vegetation characteristic of the Upper Sonoran life zones of the Mojave and Colorado deserts. Optimal habitat has been characterized as creosote bush scrub in which precipitation ranges from 50 to 203 mm (2 to 8 inches), where diversity of perennial plants is relatively high and production of annual plants is high (NatureServe 2025; Nussear and Simandle 2020). The species also occurs in creosote-bursage (*Ambrosia dumosa*) associations, shadscale (*Atriplex*) scrub, Joshua tree (*Yucca brevifolia*) parks, and mixed blackbrush scrub at higher elevations (NatureServe 2025). Tortoises are most often associated with well-drained sandy loam soils on plains, alluvial fans, and bajadas, though they occasionally occur in dunes, rocky outcrops, and vegetated alkali flats.

Desert tortoises require cover and shade to regulate body temperatures, avoid predators, and reduce water loss. Tortoises will dig burrows but will also use rock shelters, plant cover, and artificial shade. Young tortoises use existing rodent burrows rather than digging their own. Within Mojave desert scrub, desert tortoises prefer sandy loam soils and tend to avoid overly sandy soils with low water retention or soils where they are unable to construct burrows or take advantage of caliche dens (NDOW 2022). Tortoises occur in a variety of habitats from sandy flats to rocky foothills, including alluvial fans, washes, and canyons.

Key habitat features include caliche layers in washes, where tortoises dig caves between layers in arroyo walls or use caves that erode naturally. These caliche caves provide important winter den sites shared with kit fox, burrowing owls, Gila monsters, and various snakes. Desert pavements within valley bottoms are important drinking sites during brief rains, and support dense annual plant growth that is important tortoise forage when rainfall is adequate (Nussear and Simandle 2020).

The habitats occupied by Mojave desert tortoises in Clark County are diverse and can be characterized as valley bottoms, lower slopes, upper slopes, mountain slopes, and mountain passes. Areas of lower predicted habitat within Clark County include the mountainous areas in the Spring and Sheep ranges, Lucy Grey Mountains, Virgin Mountains, and southern Gold Butte (Nussear and Simandle 2020).

Within Clark County, the highest categories of predicted suitable habitat occur in Mojave Desert Scrub, Blackbrush, Mesquite Acacia, and Salt Desert Scrub communities, with smaller amounts in Desert Riparian ecosystems. Moderate habitat expands into these same ecosystems and includes a small area in the Pinyon-Juniper ecosystem, where tortoises are found but not typically in high densities (Nussear and Simandle 2020).

Habitat Suitability Model

Habitat suitability models for desert tortoise in Clark County were developed by Nussear and Simandle (2020) and subsequently updated by Nussear et al. (2024). The updated models used an ensemble approach incorporating multiple modeling algorithms: GBMs, RF, GAMs, and Maximum Entropy (MaxEnt). All models performed with high accuracy across both training and testing datasets, with AUC values ranging from 0.95 to 1.0, BI values near 1.0, and TSS scores from 0.77 to 0.99 (Nussear et al. 2024).

The relative importance of input variables differed among algorithms, but several variables were consistently influential. The coefficient of variation of winter precipitation was the dominant driver of the MaxEnt models

(93.8 percent importance), while the GBM model was primarily driven by depth to bedrock (51.4 percent) and soil sand content (37.6 percent). Average maximum temperature, depth to bedrock, soil sand content, slope, and winter precipitation each contributed substantially to at least two of the four models (Nussear et al. 2024). A version of the model incorporating a vegetation layer found that vegetation added only 2.7 percent additional explanatory power, indicating that physical and climatic variables alone capture most of the predictive information.

Predicted habitat is distributed broadly across the lower bajadas and valley floors of Clark County, with reduced predictions in higher-elevation mountainous areas. Desert tortoise localities were primarily associated with North American Warm Desert Scrub and Grassland, and Western North American Cool Semi-Desert Scrub and Grassland vegetation associations (Nussear et al. 2024). The ensemble model for Clark County is shown in Figure 15.

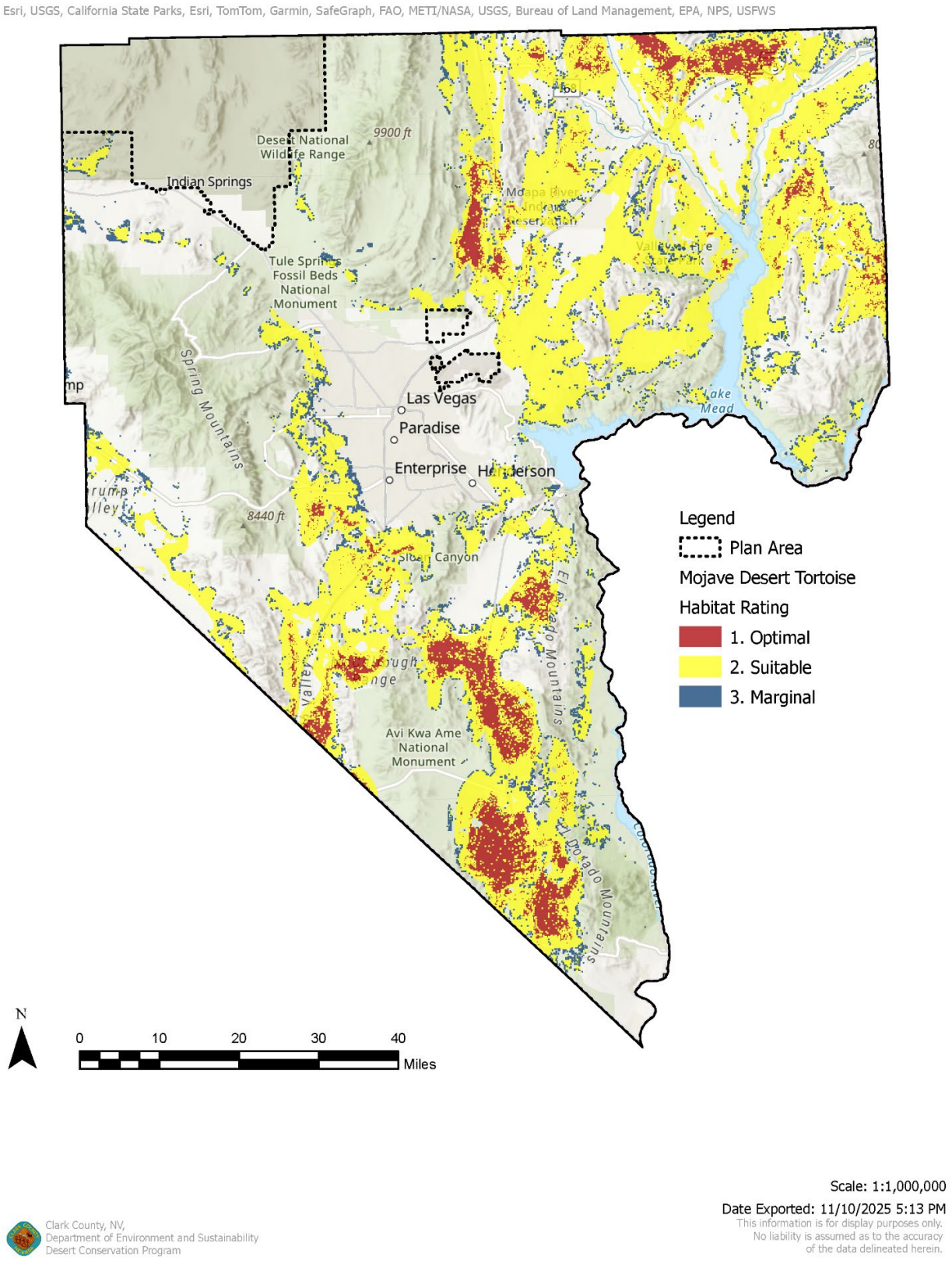

Figure 15. Habitat suitability model for the desert tortoise (*Gopherus agassizii*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Covered
U.S. Fish and Wildlife Service Endangered Species Act	Threatened
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	Threatened
State of Nevada	Threatened
State of California	Endangered
State of Arizona	Species of Greatest Conservation Need
State of Utah	Species of Greatest Conservation Need
NV Division of Natural Heritage	None
NV Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Presumed stable
NatureServe Global and NV State Rank	G2G3 S2
IUCN Red List	Critically Endangered
CITES	Appendix II Species

The Mojave desert tortoise is listed as Threatened under the U.S. Endangered Species Act, a status that has been in effect since April 2, 1990 (55 FR 12178). In a 90-day finding on a petition requesting emergency reclassification as Endangered, USFWS (2017) found that the petition was not warranted. USFWS completed a 5-year review in 2022 and recommended no change to the current Threatened classification (USFWS 2022). California designated the species a candidate for Endangered status under the California Endangered Species Act in October 2020, although this designation does not carry additional regulatory protections (USFWS 2022).

Globally, NatureServe assigns *G. agassizii* a rounded global rank of G2 (Imperiled), with a range-wide rank of G2G3, reflecting severe historical and ongoing population declines (NatureServe 2025). The global rank was reviewed as recently as June 2025. The species is ranked S2 in Arizona and Utah, and S2S3 in California and Nevada (NatureServe 2025). The IUCN reclassified the species as Critically Endangered in 2021, citing the magnitude of population trends and the status of current threats (Berry et al. 2021). The species is also listed on Appendix II of the Convention on International Trade in Endangered Species (CITES).

Population Trends

Population trend data indicate broad and continuing declines across most of the species' range. The NatureServe short-term trend for *G. agassizii* is a decline of 30 to 70 percent, and the long-term trend reflects a decline of 70 to 90 percent (NatureServe 2025). In California's western Mojave, populations may have declined nearly 90 percent since 1940, and as much as 70 percent locally between 1976 and 1984. The Beaver Dam Slope population in Utah declined by approximately 80 percent from the 1940s to 1990 (NatureServe 2025).

Between 2004 and 2014, the total number of adult tortoises declined by an estimated 124,050 individuals (37 percent) from an estimated 336,393 range-wide (USFWS 2022; Allison and McLuckie 2018). Populations

declined on average in every Tortoise Conservation Area (TCA) except those in the Northeastern Mojave Recovery Unit and in Joshua Tree and Piute Valley in the Colorado Desert Recovery Unit. Mean density of adult tortoises in 11 of the 17 TCAs fell below 3.9 per square kilometer, considered the minimum viable density for the species (USFWS 2022). The global adult population was estimated at approximately 212,343 individuals in 2014 (Allison and McLuckie 2018).

In Nevada, populations in most TCAs showed positive trends between 2004 and 2014, contrasting with broader range-wide declines (Allison and McLuckie 2018; NDOW 2022). The Beaver Dam Slope TCA in the Northeastern Mojave Recovery Unit showed particularly strong positive trends during that period. The NDOW 2022 State Wildlife Action Plan characterizes the statewide population trend as declining 10 to 30 percent but correctable (NDOW 2022). Populations in other recovery units across the range have declined by as high as 50 percent since 2004.

Declining reproductive output across much of the Mojave desert tortoise's range, as estimated between 1990 and 2018, could have negative population-level effects if precipitation is significantly reduced as predicted under some climate models (Mitchell et al. 2021). The long-lived nature of the species and its low recruitment rate require longer monitoring periods to obtain accurate trend estimates (NDOW 2022).

NatureServe characterizes the species as highly vulnerable on the basis of life-history traits: sexual maturity is reached in 13 to 20 years, fecundity is relatively low, juvenile survival is low, and the species tends to show strong site fidelity (NatureServe 2025). These traits constrain the rate at which populations can recover from disturbance. Natural population recovery is slow, with best-case scenarios projecting approximately 1 percent population growth per year, corresponding to a doubling time of about 70 years; at a more realistic rate of 0.5 percent, the doubling time increases to approximately 140 years (NatureServe 2025). A demographically stable population is expected to show specific age-class proportions of approximately 22 percent hatchlings, 22 percent small juveniles, 6 percent larger juveniles, 8 percent subadults, and 42 percent adults; populations consisting entirely of adults, or of adults and hatchlings or neonates, may not be undergoing progressive replacement (NatureServe 2025).

Habitat Level Threats

Ecosystem-level threats to Mojave desert tortoises and their habitats can be widespread and may be direct or indirect. Activities that create surface disturbances can damage vegetation, disturb seed banks, and increase erosion by water and wind, leading to further desertification by altering soil surfaces and reducing the ability of water to infiltrate (Nussear and Simandle 2020). The largest threat to this species' habitat is loss and degradation through urban and suburban development. Development also fragments large expanses of habitat and reduces genetic flow between subpopulations (USFWS 2011).

Invasive grass-fueled wildfires remain a persistent concern. Increases in Mediterranean grasses such as *Bromus* and *Schismus* species have led to extensive wildfires throughout the range. Desert wildfires are known to kill more than 10 percent of adult tortoise populations in a single event (Nussear and Simandle 2020). Non-native plant invasions cause increased wildfire frequency, from which desert vegetation is very slow to recover, and habitat is at risk of permanent conversion through repeated cycles of wildfire and re-invasion (USFWS 2011). Atmospheric nitrogen deposition resulting from internal combustion engines and other urban activities can increase invasive annual grasses and forbs while reducing native forbs that tortoises depend on (Nussear and Simandle 2020).

Transportation corridors represent a significant and well-documented threat to habitat connectivity for the Mojave desert tortoise throughout their range. A large portion of tortoise habitat is intersected by highways,

railroads, and recreational routes (USFWS 2011). The majority of TCAs are divided internally or separated from adjacent units by major roads and highways (Averill-Murray et al. 2021). Road effect zones, defined as the distance from a road at which effects to wildlife are detected, result in reduced tortoise abundance at greater distances from the roadway as traffic volume increases; these effects have been documented on roads with traffic volumes ranging from 220 to 5,000 average annual daily vehicles (Nafus et al. 2013; Peaden et al. 2015). Transportation corridors also serve as conduits for subsidized predators such as ravens and facilitate the spread of invasive plant species, further degrading habitat quality in adjacent areas (Boarman et al. 1997). Connectivity modeling conducted for the Desert Conservation Program predicted that disturbance scenarios in the Ivanpah Valley related to I-15 and associated development are expected to result in near-complete loss of connectivity and isolated tortoise population clusters (Dutcher et al. 2019). Off-highway vehicle use has similarly increased route density throughout the county, resulting in degradation, loss, and potential fragmentation of desert tortoise habitat through loss of native vegetation, soil compaction, and formation of berms and depressions that impede tortoise movement (Berry and Murphy 2019; RECON Environmental, Inc. 2022).

Since the revised recovery plan was published in 2011, large areas of desert tortoise habitat have been developed or approved for utility-scale solar energy development, collectively accounting for approximately 74,000 acres across recovery units (USFWS 2022). Solar energy development has increased dramatically within the Northeastern Mojave Recovery Unit and represents a high-rated threat to the species in Nevada (NDOW 2022). New threats include the rapid increase in illegal cannabis farms in the Mojave Desert, where bulldozers scrape native vegetation and topsoil in designated critical habitat (USFWS 2022).

Climate change is projected to substantially reduce and shift suitable desert tortoise habitat upslope. The climate in the southwestern United States from 2000 through 2021 was the driest 22-year period in over 1,200 years (Williams et al. 2022). Rising temperatures are projected to reduce activity periods, and droughts reduce food availability. Off-highway vehicle disturbance of cryptobiotic crusts exposes underlying soils to wind erosion, increasing sandy substrate in areas that were previously suitable for burrowing (Nussear and Simandle 2020).

Threats to Species

The primary threats to *G. agassizii* include habitat loss, habitat degradation and fragmentation, climate change, and direct mortality (NatureServe 2025). The species' life history characteristics, including low juvenile survival and slow population growth rates, reduce the ability of populations to recover from external threats (USFWS 2011).

Direct mortality from vehicle collisions is a significant threat, particularly along roadways without exclusion fencing. Research confirms that tortoises are essentially absent from habitat within 1 km of areas with greater than 10 percent development (Carter et al. 2020), and all tortoise populations declined in TCAs with road densities above 0.75 km/km² (USFWS 2022). Deliberate harassment, collection for commercial or recreational purposes, and illegal shooting are also known threats (USFWS 2011). Beyond direct mortality, roads fragment habitat and reduce genetic connectivity between subpopulations. Connectivity modeling conducted for the Desert Conservation Program showed that anthropogenic disturbance reduces gene flow and population size, and that current and planned development activities are projected to result in population declines and loss of genetic connectivity over a 100-year simulation period (Dutcher et al. 2019; Nussear et al. 2022). Tortoises are more likely to move among activity centers when potential movement areas are situated farther from minor roads and where adjacent roadways have barrier fencing (Sadoti et al. 2017). Data analysis from culvert studies along US-93 and US-95 in Clark County confirmed that culverts

function as connectivity conduits for tortoises, though they did not appear to fully equalize tortoise abundance on either side of fenced highways (Heron Ecological 2022). Behavioral data also indicate that tortoises are more likely to enter resting states when nearer to highways, suggesting an indirect impact of roads on population-level movement patterns beyond direct road mortality (Heron Ecological 2022).

Predation by subsidized common raven (*Corvus corax*) and coyote (*Canis latrans*) populations represents an ongoing threat to juvenile recruitment. Human-derived food subsidies such as open trash bins, pet food, and leaky watering systems have allowed these predators to colonize areas at unnaturally high densities (Nussear and Simandle 2020). American badgers (*Taxidea taxus*) and mountain lions (*Puma concolor*) are also known to prey on tortoises. Feral and free-roaming pets pose increased predation risk in areas with large wildland-urban interfaces (USFWS 2011).

Upper respiratory tract disease (URTD) caused by *Mycoplasma agassizii* and *M. testudineum* is present throughout the range of the species. The impacts of URTD on tortoise survival are not yet thoroughly understood, and no effective cure is available (USFWS 2022). The relative contribution of URTD to population declines remains unresolved, although the disease is widespread across the range and is sometimes externally asymptomatic even in seropositive individuals (NatureServe 2025). Other organisms known or suspected to infect Mojave desert tortoises include herpesvirus, shell and skin fungi, pneumonia, *Cryptosporidium*, and *Chlamydia*. Captive or pet tortoises released into the wild can introduce diseases into wild populations and result in genetic contamination (Nussear and Simandle 2020).

Diets high in invasive brome grass result in slow growth, reduced survival, and other health hazards for juvenile Mojave desert tortoises (Nussear and Simandle 2020). Military training-land expansions have also displaced tortoises; approximately 650 tortoises were translocated from Fort Irwin and approximately 1,000 from the Marine Corps Air Ground Combat Center expansion at Twentynine Palms (USFWS 2022).

Anthropogenic litter also poses a direct threat. Released balloons can travel long distances and accumulate in remote natural areas occupied by tortoises; tortoises may ingest balloon fragments and suffer intestinal blockage, or become entangled in the attached strings (Walde et al. 2007; NatureServe 2025).

Fire is known to cause direct mortality to tortoises and has been suspected of causing habitat degradation, but individual tortoises generally do not change territories after fire, and the demographic impacts of fire on surviving populations are not yet fully understood (Lovich et al. 2018).

Conservation and Management

The 1994 Mojave Desert Tortoise (Mojave Population) Recovery Plan (USFWS 1994), revised in 2011 (USFWS 2011), describes a strategy for recovering the Mojave population. The recovery plan identifies six recovery units, a system of Desert Wildlife Management Areas (DWMAs), and specific recovery actions. The BLM administers DWMAs as Areas of Critical Environmental Concern (ACEC). In Nevada, BLM field offices manage more than 940,000 acres of Mojave desert tortoise habitat designated as ACECs (Nussear and Simandle 2020).

In Nevada, the Mojave desert tortoise is protected under Nevada Administrative Code 503.080, wherein the species is listed as a state-protected reptile classified as Threatened, and collection is controlled under section 503.093. The species is also considered a Species of Greatest Conservation Need under the Nevada Wildlife Action Plan, implemented by NDOW (NDOW 2022). The State Wildlife Action Plan recommends protecting large tracts of suitable tortoise habitat well dispersed throughout the range, maintaining the species' habitat at its current distribution in a stable or increasing trend, and obtaining no net unmitigated

loss or fragmentation of habitat in designated management areas. The Nevada State Wildlife Action Plan identifies a suite of research and management priorities for the Mojave desert tortoise in Nevada, which align closely with range-wide recovery needs (NDOW 2022). Priority research needs include defining corridors for genetic connectivity and identifying refugia under forecasted climate change scenarios; assessing impacts from utility-scale solar energy development and refining best management practices for siting, mitigation, and minimization; and evaluating the effects of large-scale and repeated fires on distribution and population connectivity (NDOW 2022). Additional priorities include determining the ability of solar energy facilities to support tortoise movement by leaving washes and native vegetation intact, and the design and spacing of highway underpasses necessary to maintain demographic and genetic connectivity across roads. Priority management actions include protecting mature breeding adults, limiting unnatural pressures on hatchlings by slowing the progression of invasive weeds and reducing food subsidies for mesocarnivores, ensuring core habitat is not fragmented and that movement corridors are maintained between population subsets, and extending surface-disturbance caps similar to those enacted by the Desert Renewable Energy Conservation Plan in California to the remainder of the Mojave desert tortoise's range (NDOW 2022). NDOW also identifies population augmentation, consistent with the Fish and Wildlife Service population augmentation strategy, as a tool for achieving recovery criteria in each of the five recovery units, alongside targeted predator control to reduce subsidized predation, fire prevention and management to contain the grass-fire cycle, and the installation and maintenance of tortoise barrier fencing along priority highway segments (NDOW 2022).

The Nevada Department of Transportation and Clark County have taken action to protect Mojave desert tortoises on Nevada highways by installing exclusion fencing along many roadways that traverse tortoise habitat. Annual road mortality has decreased by 75 percent or greater with the installation of exclusion fencing (Nussear and Simandle 2020). In Clark County, the Mojave population is also covered under the Lower Colorado River Multi-Species Conservation Program and the Coyote Springs Investment Multiple-Species Habitat Conservation Plan.

The Clark County Desert Conservation Program developed a Connectivity Management Plan to assess the current state of desert tortoise connectivity throughout the county, investigate threats and barriers to connectivity, and identify potential conservation solutions (RECON Environmental, Inc. 2022). The plan synthesized results from multiple studies, including omni-directional connectivity modeling, culvert inspection and passability assessments, mark-recapture surveys near highway culverts, genetic connectivity simulations, and individual-based connectivity solutions modeling. Priority management recommendations from the plan include ensuring tortoise exclusion fencing is connected to grade 1 to 3 culverts, repairing or improving grade 4 to 5 culverts at key locations, conducting herbicide treatments to clear invasive vegetation obstructing culvert openings, and extending exclusion fencing along roadway segments identified as priorities for maintaining connectivity and genetic diversity (RECON Environmental, Inc. 2022). The USFWS Revised Recovery Plan (USFWS 2011) Recovery Action 2.11 calls for connecting isolated blocks of desert tortoise habitat through natural habitat corridors and culverts across fenced roads and railroads, which the Connectivity Management Plan directly implements within Clark County.

BLM ACECs, NPS lands, other lands allocated for resource conservation such as the Boulder City Conservation Easement, and MSHCP conserved lands provide an extensive network of habitats managed directly or indirectly for desert tortoise conservation in Clark County.

Within Clark County, Nussear et al. (2024) modeled desert tortoise habitat suitability on the basis of winter precipitation, soil substrate, and maximum air temperature. The acreages of suitable desert tortoise habitat

within the MSHCP Amendment Plan Area and associated management categories are summarized in the table below.

Desert tortoise (*Gopherus agassizii*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	1,539,043	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	102,374	6.7%
Suitable Habitat in Lands Managed for Resource Conservation	821,703	53.4%
Suitable Habitat in the existing MSHCP Reserve System	58,854	3.8%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	127,017	8.3%

*Nussear et al. 2024

Clark County Survey Data

Desert tortoise population data collection was initiated in the period from 1978 to 1983, with permanent population monitoring study plots established beginning in 1976 through a network sponsored by BLM and NDOW. These plots were typically 1 square mile in area, selected to represent a range of local habitat types, and re-sampled on a roughly 5-year rotation (Nussear and Simandle 2020). Annual range-wide population monitoring using line distance transects began in 2001. Multiple long-term data collection methodologies have since been utilized to monitor population trends (USFWS 2022).

The Clark County Desert Conservation Program has conducted systematic desert tortoise surveys and monitoring as part of the existing MSHCP. Population density estimates of adult tortoises resulting from range-wide surveys varied among recovery units and years. Recent reports indicate increasing trends in the Northeast Mojave, which is largely composed of Clark County (Nussear and Simandle 2020).

In Nevada, populations in most TCAs showed positive trends between 2004 and 2014, with the Beaver Dam Slope TCA in the Northeastern Mojave Recovery Unit showing particularly strong positive trends (Allison and McLuckie 2018; NDOW 2022).

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Gila Monster (*Heloderma suspectum*)

Photo Source: Project 2023-USGSS-2315H

Photo Credit: Jason Jones (Project 2021-GBI-2040C)

Species Overview

Gila monsters are large (350 to 500 mm in length) venomous lizards. They are brightly colored, yet cryptic, and have a short activity period of approximately 90 days from April to mid-June, with limited activity on only about one third of days during their activity season (Beck 1990). They are most commonly observed above ground during daylight hours in April and May. During summer months, longer movements are restricted, but they remain active crepuscularly and nocturnally and during monsoonal rains. They largely remain in burrows during winter, though occasional above-ground movement occurs during optimal temperatures (NDOW 2022). Gila monsters are strongly associated with burrows and deep caves, and as such are frequently found in rocky (e.g., sandstone) or mountainous terrain. They are secretive diurnal predators that feed largely on the eggs and young of desert vertebrates, foraging widely on sandy areas and bajadas in the desert scrub habitats surrounding their shelter sites.

Gila monsters spend up to 98 percent of their lives underground (Beck 2005, Beck and Jennings 2003), retreating to sub-surface refuge sites that buffer extreme above-ground temperatures. Refuge site selection is thermally mediated and shifts seasonally: Gila monsters select progressively deeper shelters as surface temperatures increase through the spring and summer, and select shallower sites in early spring and fall when thermal conditions are cooler (Gienger et al. 2021). Individual shelters may be reused across years and by multiple individuals, and a single shelter has been documented in use across 16 years of observation (Gienger et al. 2021a). Gila monsters are long-lived, exceeding 20 years in the wild and 30 years in captivity (Beck 2005). Home ranges in Clark County vary considerably among individuals and years; density estimates for two Clark County populations averaged approximately 150 and 58 hectares, and annual home range area for a given individual can vary by more than an order of magnitude across years (Gienger et al. 2021).

Early studies recognized two subspecies (*Heloderma suspectum suspectum*, the reticulate variety found in Arizona and Mexico, and *Heloderma suspectum cinctum*, the banded variety found in Nevada and Utah), although recent genetic analysis refutes this subspecific split (Douglas et al. 2010, NDOW 2022).

Range

Gila monsters range across portions of the Sonoran, Mojave, and Chihuahuan deserts in the U.S. and Mexico. Within the United States, the Gila monster inhabits isolated locales within extreme southwestern Utah, southern Nevada (Clark, Lincoln, and Nye counties), southeastern California (within San Bernardino County),

and southern and western Arizona (Stebbins 2003). Gila monsters can be found in many habitats between 2,500 and 5,000 feet but most commonly frequent the lower slopes of mountains and adjoining canyon bottoms and arroyos and are frequently associated with rocky terrain (Bogert and del Campo 1956, Funk 1966) in areas with natural shelters and caves (Beck and Jennings 2003, Gienger 2003). Gila monsters are thought to be absent from areas with low summer precipitation (e.g., Organ Pipe National Monument in Arizona [Bogert and del Campo 1956]).

Approximately 25 percent of the Gila monster's entire range occurs in Clark County (Stebbins 2003), and Clark County is at the northern extent of the range. Distribution of the Gila monster within Clark County is generally coincident with the distribution of Mojave desert tortoise and common chuckwalla (*Sauromalus ater*); however, little information exists on detailed distribution and relative abundance in Nevada (NDOW 2007). Recent research conducted by NDOW indicates that Gila monsters are more common than expected in the McCullough Mountains.

Habitat Characteristics

Gila monsters occupy rocky desert scrub habitats characterized by shrubby, grassy, and succulent vegetation (NDOW 2022). Common habitat for the Gila monster is characterized by complex rocky landscapes of upland desert scrub adjacent to suitable foraging sites harboring appropriate prey and nests thereof (Beck 1990, Gienger 2003). The species tends to avoid the harshest desert environments given its physiological constraints (Beck 2005) and is most frequently found on the lower slopes of mountains and foothills, particularly where these habitats are juxtaposed with washes and canyon bottoms. In Nevada the species occurs primarily in Mojave Warm Desert and Mojave Mid-Elevation Mixed Desert Scrub vegetation types (NDOW 2022). Most localities are also associated with desert wash, spring, and riparian areas, including those along the lower Colorado River drainage (Funk 1966, Lovich and Beaman 2007, NDOW 2007).

Sub-surface shelter sites are a critical habitat component. Gila monsters do not excavate their own shelters and instead use sandstone crevices, rocky slopes or debris flows, rodent burrows, and desert tortoise burrows (Gienger et al. 2021). In Clark County, sandstone crevices and rocky slopes together accounted for approximately 85 percent of shelters used, rodent burrows accounted for approximately 12 percent, and tortoise burrows approximately 3 percent (Gienger et al. 2021). Rodent burrows are used primarily during spring foraging, when nests of rodents, reptiles, and ground-nesting birds are available as prey. Shelter depth, rather than entrance orientation or roof structure, is the shelter attribute most strongly linked to seasonal selection: summer shelters are significantly deeper than spring or fall shelters, allowing Gila monsters to avoid potentially lethal surface temperatures (Gienger et al. 2021). Shelters selected by Gila monsters are more thermally stable than unused shelters with similar physical attributes and never exceeded 40 degrees Celsius in one Clark County study, whereas the critical thermal maximum for the species is 42.5 degrees Celsius (Bogert and del Campo 1956, Gienger et al. 2021, Gienger et al. 2025). Individual shelters are reused across years and by multiple individuals, and a shelter documented in use in 2002 was occupied again in 2020, sixteen years later (Gienger et al. 2021a). Gila monsters winter at more elevated locations (i.e., on rocky slopes, in rocky outcrops, or below cliffs), often with other reptiles such as rattlesnakes and desert tortoises. Summer ranges, however, are located in adjacent lower valleys or alluvial fans (Jennings and Hayes 2004) where the prey base is larger. Refuges are consistently used across seasons and across years, and individual Gila monsters show strong site fidelity to specific refuge locations, underscoring the conservation importance of landscapes that contain complexes of thermally suitable shelter features (Gienger et al. 2025, Stalker et al. 2023).

Habitat Suitability Model

Habitat suitability for the Gila monster in Clark County was modeled by Simandle and Nussear (2025) using an ensemble modeling approach that combined generalized additive models, gradient boosted machines, MaxEnt, and random forests. Model performance was strong, with a testing Area Under the Receiver Operator Curve of 0.9938, a TSS of 0.9162, and a continuous BI indicating that at habitat suitability values above approximately 0.80, observed presence is up to 20 times higher than random expectation (Simandle and Nussear 2025). The locality dataset consisted of 3,157 records within the buffered modeling area, which were spatially thinned to 594 records for model training and testing. Model discussion below refers to the ensemble model run without Clark County vegetation divisions and with the buffered modeling area, which was the version used to derive suitable habitat acreages for the MSHCP Amendment Plan Area.

Four environmental covariates made the largest contributions to the ensemble model. The coefficient of variation of minimum temperature (CVMinTemp) was influential in all four component model types; suitability is low at low CVMinTemp values, increases to a peak near 2.4, and declines at higher values. The coefficient of variation of winter precipitation (wpcv) was important in three of the four models, with suitability rising sharply toward 0.66 and declining steeply above 0.68. Maximum vapor pressure deficit (vpdMax) was important in two models, with suitability climbing rapidly from low values to a maximum near 35 hPa before decreasing at higher values. Distance to cliffs (Dist2Cliff) was important in three models, with suitability highest near cliffs and dropping quickly as distance increases (Simandle and Nussear 2025). Together these variables indicate that Gila monster habitat is best predicted by a combination of thermal variability, winter precipitation regime, evaporative demand, and proximity to rocky escarpment features that provide shelter.

Predicted habitat suitability is broadly distributed across Clark County and the buffered modeling area. Highly suitable habitat occurs at mid to higher elevations, while suitability is low in valleys and lowlands and at extremely high elevations. Within Clark County, highly suitable habitat is concentrated in the Sheep Range and adjacent portions of the Las Vegas Range, in the Muddy Mountains, along the southeast edge of the Spring Mountains, and in the McCullough Range, with moderately suitable habitat distributed widely throughout the region (Simandle and Nussear 2025). Modeled Gila monster habitat suitability in Clark County is shown in Figure 16.

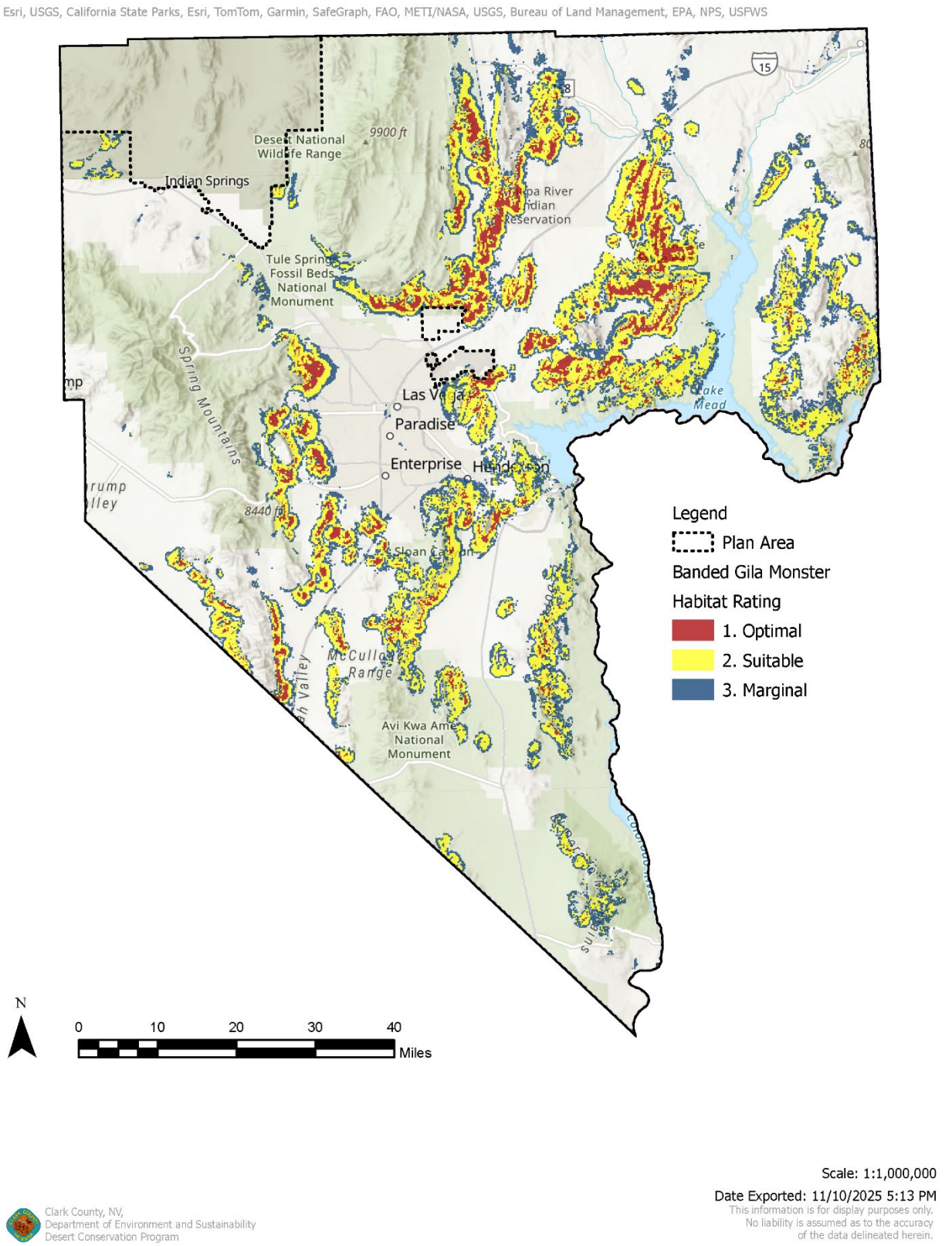

Figure 16. Habitat suitability model for the Gila monster (*Heloderma suspectum*) in Clark County, Nevada (Simandle and Nussear 2025).

A complementary Clark County ensemble habitat model developed by Nussear and Hromada (2022), and subsequently published in peer-reviewed form by Hromada et al. (2025), paired the habitat suitability model with an empirical Gila monster movement model fit to multi-year telemetry data from Red Rock Canyon National Conservation Area and the Sloan Canyon area. The movement model indicated that Gila monsters prefer to move through areas with moderate slope, higher shrub cover, and incised washes, and avoid flat, low-cover valley bottoms and highly impervious surfaces (Hromada et al. 2025). Coupling habitat suitability projections with this movement surface and a 3 km dispersal limit showed that projected occupied habitat in Clark County is expected to remain near current levels under a low-emissions scenario through 2082, but to decline substantially under a high-emissions scenario, with extensive loss of suitable habitat in the Interstate 15 corridor and lower elevations around Lake Mead (Hromada et al. 2025). Lower-elevation areas of the Spring, Sheep, Muddy, McCullough, Virgin, and Mormon mountains are identified as potential climate refugia where currently suitable habitat is most likely to persist into the late 21st century (Hromada et al. 2025). An independent range-wide habitat model by Gehman and Gienger (2025) similarly identified rocky, mid-elevation terrain as the primary driver of suitable habitat and found that only a modest fraction of the species' predicted range currently falls within protected natural areas.

Species Status

Agency/Organization	Status
MSHCP (2000)	Evaluation
U.S. Fish and Wildlife Service Endangered Species Act	None
U.S. Bureau of Land Management (Nevada)	Sensitive[1]
U.S. Forest Service (Region 4)	None
State of Nevada	Protected
State of California	Species of Special Concern
State of Arizona	Species of Greatest Conservation Need
State of Utah	Species of Greatest Conservation Need
NV Division of Natural Heritage	At Risk
NV Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Highly Vulnerable
NatureServe Global and NV State Rank	G4 S2
IUCN Red List	Near Threatened
CITES	Appendix II Species

[1] Designation is at the subspecies level of banded Gila monster, *Heloderma suspectum cinctum*.

The Gila monster holds a range of status designations across federal, state, and international authorities. NatureServe assigns a global rank of G4 (apparently secure) and a state rank of S2 (imperiled) for Nevada, with a subspecies rank of T3 (vulnerable) applied to *H. s. cinctum* (NatureServe 2026). The International Union for Conservation of Nature (IUCN) Red List classifies the species as Near Threatened, and the CITES lists the species under Appendix II, which regulates commercial trade. The 2022 Nevada State Wildlife Action Plan (NDOW 2022) identifies the Gila monster as a Species of Greatest Conservation Need, and the Nevada Climate Change Vulnerability Index rates the species as Highly Vulnerable. The Gila monster has state-protected status in Nevada, Utah, and Arizona, which prohibits collection for personal or commercial purposes (NDOW 2009). The Gila monster was petitioned for listing under the Endangered Species Act as a

distinct population segment in Utah in 2010 (WildEarth and Beck 2010). The petitioners cited substantial losses of individuals due to habitat loss, although census data were not available. The USFWS determined that the petition did not present substantial scientific or commercial information indicating that the Utah population qualifies as a distinct population segment and that listing may be warranted, and declined to proceed to a 12-month status review (USFWS 2011). Prior USFWS actions in 1982 included consideration of this species as a Category 2 candidate, as a broad inclusion of species for which listing may have been warranted; the Gila monster was later removed when the Category 2 designation was discontinued due to lack of sufficient information to justify listing (USFWS 1996).

Population Trends

Gila monsters are rarely observed in nature, which makes it difficult to determine population trends. Most experts believe that populations are declining over most of the range, but the rate of decline is unknown (NatureServe 2026). WildEarth and Beck (2010) estimated that populations have declined from thousands to hundreds in Washington County, Utah; however, these estimates are not based on quantitative field surveys. Within Clark County, baseline population data are lacking and trend is considered unknown, although suitable habitat has likely decreased (NDOW 2022). Population genetic analysis by Wood and Vandergast (2023) indicates that Clark County populations are of sufficient size and diversity to stave off inbreeding and demographic decline and are of comparable size to those of protected Saguaro National Park. Northeast Clark County in particular provides a regional stronghold for the species and shows a higher degree of genetic diversity, representing the historic intergrade between the Nevada and Utah populations (Wood and Vandergast 2023).

Habitat Level Threats

Habitat loss and fragmentation from housing and urban development are the principal landscape-scale threats to the Gila monster in Clark County. Existing and projected expanded housing developments reduce and fragment suitable habitat (NDOW 2022). Associated linear infrastructure creates barriers to dispersal: Highway 160 and Interstate 15 represent likely movement barriers for the Calico and Blue Diamond Hills populations and contribute to loss of genetic connectivity (Wood and Vandergast 2023). Motorized off-highway vehicle use, concentrated hiking and rock climbing, and the proliferation of dispersed travel routes also degrade habitat and fragment otherwise suitable areas (NDOW 2022).

The spread of non-native annual grasses, including cheatgrass (*Bromus tectorum*) and red brome (*Bromus rubens*), alters habitat structure and increases wildfire frequency in the Mojave Desert, both of which likely reduce habitat suitability for the Gila monster (NDOW 2022). Persistent climate change-induced droughts are expected to further reduce habitat suitability through effects on prey availability, and the Nevada Climate Change Vulnerability Index rates the species as Highly Vulnerable (NDOW 2022). Gila monsters have high rates of evaporative water loss, with a significant increase when exposed to temperatures over 35 degrees Celsius (DeNardo et al. 2004), which makes the species particularly sensitive to warming and drying trends.

Climate projections for Clark County indicate that suitable and reachable Gila monster habitat is likely to remain near current levels under a low-emissions scenario but to decline substantially under a high-emissions scenario by the late 21st century, with the greatest losses projected in lower-elevation areas around the Interstate 15 corridor and Lake Mead National Recreation Area (Hromada et al. 2025). Landscape genetic analysis across Clark County further indicates that climate variables, particularly minimum temperature of the coldest month and annual temperature range, are significantly associated with genetic differentiation among Gila monster populations beyond the effect of geographic distance alone (Wood and

Vandergast 2023). This pattern suggests that climate-driven shifts in habitat suitability and connectivity may have adaptive as well as demographic consequences for peripheral Nevada populations (Wood and Vandergast 2023).

Threats to Species

Direct threats to the Gila monster, including those in Clark County, include illegal collection for commercial and recreational purposes and injury and mortality resulting from collisions with vehicles on paved and unpaved roads (AGFD 2002). Predation is also a threat to this species. As urbanization becomes more prevalent in previously uninhabited deserts, human and pet densities increase, as do densities of subsidized predators (Esque et al. 2010). Pet encounters with wildlife are presumed to be a contributing factor in Gila monster declines (Jennings and Hayes 2004, WildEarth and Beck 2010). The Gila monster has a venomous bite and has therefore been the target of unwarranted destruction by humans (NDOW 2009, WildEarth and Beck 2010). Gila monsters are also at risk of genetic diversity loss resulting from habitat fragmentation and barriers to dispersal (Wood and Vandergast 2023). Translocation of individuals away from urban locations does not appear to be an effective conservation tool: in Arizona, individuals moved less than 1,000 m from the site of capture returned within 30 days, whereas those translocated farther incurred a high mortality rate (Sullivan et al. 2004).

Conservation and Management

The Gila monster is covered under the 1998 Conservation Agreement for the Spring Mountain Range. The Gila monster is also included as a Covered Species in the Coyote Springs Investment Multiple-Species Habitat Conservation Plan published in July 2008 and the corresponding Endangered Species Act section 10(a)(1)(B) incidental take permit issued by the USFWS in October 2008 (Coyote Springs Investment Multiple-Species Habitat Conservation Plan 2008). The Coyote Springs Investment MSHCP area covers portions of Clark and Lincoln counties, north of the Clark County MSHCP area. The Clark County Desert Conservation Program has supported survey, monitoring, genetic, and habitat modeling efforts for Gila monsters in Clark County (Gienger et al. 2021, Wood and Vandergast 2023, Simandle and Nussear 2025). Landscape genetic analyses have identified a narrow remaining corridor of suitable habitat connecting the Calico and Blue Diamond Hills with the North McCullough and Sloan Canyon Wilderness Areas as an area of high conservation importance for maintaining gene flow between populations east and west of Las Vegas; this corridor is bisected by State Route 160 and Interstate 15, which are associated with elevated genetic differentiation (Wood and Vandergast 2023). Continued occupancy surveys in this corridor, together with evaluation of existing culverts and undercrossing structures along bisecting highways, have been recommended to support regional connectivity (Wood and Vandergast 2023). Genetic management recommendations include prioritizing northeastern Clark County, which encompasses Moapa Valley, Valley of Fire, the Muddy Mountains, Gale Hills, and the Dry Lake Range west of Interstate 15, for additional sampling and protection, given its role as a historic zone of admixture between the Nevada and Utah genetic clusters and its relatively low level of urban development (Wood and Vandergast 2023). If future translocation is considered, source sites should be drawn from within the same regional genetic cluster and with similar climatic conditions as the recipient site (Wood and Vandergast 2023).

Modeled suitable habitat for the Gila monster covers approximately 1,021,803 acres within the MSHCP Amendment Plan Area. Of this total, the Impact Area encompasses 52,929 acres (5.2 percent). Lands managed for resource conservation contain 598,057 acres of suitable habitat, representing 58.5 percent of the total habitat within the Plan Area (Simandle and Nussear 2025). The existing MSHCP Reserve System

includes 8,141 acres (0.8 percent), and the MSHCP Amendment Reserve System Additions account for an additional 108,634 acres (10.6 percent) of suitable Gila monster habitat.

Gila monster (*Heloderma suspectum*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	1,021,803	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	52,929	5.2%
Suitable Habitat in Lands Managed for Resource Conservation	598,057	58.5%
Suitable Habitat in the existing MSHCP Reserve System	8,141	0.8%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	108,634	10.6%

*Simandle and Nussear 2025

Clark County Survey Data

Gila monsters spend up to 98 percent of their lives underground (Beck 2005, Beck and Jennings 2003), which makes them difficult to observe and survey. Infrequent observations should not be interpreted as low likelihood of occurrence, as they are known to occur throughout Clark County. Dedicated Gila monster survey methodology has not been formally developed, and the 2022 Nevada State Wildlife Action Plan identifies development of survey methods and population monitoring as a research priority for the species (NDOW 2022).

Gienger (2003) conducted a telemetry-based study of Gila monster ecology in Nevada, tracking lizards near Red Rock Canyon National Conservation Area and documenting mean home range size of 64.2 hectares, larger than home range estimates reported for the species in Utah, Arizona, or New Mexico.

Austin Peay State University and the Nevada Department of Wildlife conducted multi-year telemetry, habitat use, and shelter ecology investigations at two Clark County sites from 2001 through 2021 (Gienger et al. 2020, Gienger et al. 2021). The 2020 annual report documented home range, movement, and thermally mediated shelter selection for 14 radio-tagged individuals, with mean Minimum Convex Polygon home range of 55.44 hectares and mean 95 percent Kernel Density Estimate home range of 101.14 hectares (Gienger et al. 2020). The 2021 final report synthesized up to five consecutive years of telemetry data from 31 individuals across two populations and reported home ranges averaging 149.8 hectares at the lower-elevation site and 58.3 hectares at the higher-elevation site (Gienger et al. 2021). The same investigation documented thermally mediated shelter selection: Gila monsters select deeper shelters as seasonal surface temperatures increase, and selected shelters had higher thermal quality and greater thermal stability than paired or random shelters, particularly during the hottest months of June and July (Gienger et al. 2021). A single shelter site was documented in use in 2002, 2003, and 2004 by the same individual and then again in 2020 by a different individual, establishing the longest known record of repeated shelter use in the species (Gienger et al. 2021a).

The Clark County Desert Conservation Program and the USGS conducted a range-wide genetic assessment of Nevada Gila monsters under Project 2019-USGS-1997A (Wood and Vandergast 2023). Results indicate that Clark County populations are demographically viable and of conservation significance, with northeast Clark County representing a regional stronghold and a historic intergrade zone with Utah populations (Wood and Vandergast 2023).

A follow-up genetic sampling effort conducted by Austin Peay State University under Project 2023-AUSTINPEAY-2350A surveyed 11 sites across Clark County from April through July 2025, targeting focal sites and regions previously identified as undersampled, including the area encompassing Moapa Valley, Valley of Fire, Muddy Mountains, Gale Hills, and the Dry Lake Range, and the region connecting Red Rock Canyon, Blue Diamond, Sloan, and the McCullough Range (2025Gienger 2025). Survey effort totaled 391 km of visual encounter transects distributed across 739 hours of search time over 375 individual surveys, resulting in 14 live encounters with Gila monsters and eight blood samples collected for genetic analysis (2025Gienger 2025). The low encounter rate per unit of effort, even at sites with known historical occurrence, reinforces the conclusion that Gila monsters are exceptionally difficult to detect using standard visual encounter methods and that coupling field surveys with predictive habitat models and repeated visits is necessary to characterize site occupancy (2025Gienger 2025). Development of a formal survey protocol and monitoring framework suitable for assessing species status and responses to management actions has been identified as a priority research need (2025Gienger 2025, NDOW 2022).

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Species Accounts
Amphibians

Arizona Toad (*Anaxyrus microscaphus*)

Photo Credit: U.S. Geological Survey

Photo Credit: U.S. Geological Survey

Species Overview

The Arizona toad (*Anaxyrus microscaphus*) is a medium-sized bufonid toad, generally 51 to 76 mm in length, characterized by a low number of reddish-brown warts, absence of cranial crests, and oval, widely separated parotoid glands that are pale toward the front. The dorsum is gray to light brown (NDOW 2022). The species is the only toad in the arid southwestern United States restricted to riverine corridors and adjacent uplands, occupying a variety of biotic communities and elevations across its range (Oyler-McCance et al. 2024). Adults are primarily nocturnal except during the breeding season, and are inactive in cold temperatures, active at ambient temperatures of approximately 22 to 35 degrees C (NatureServe 2026). Newly metamorphosed individuals are often active during daylight hours. Diet consists of invertebrates including snails, crickets, beetles, and ants, with occasional cannibalism of newly metamorphosed individuals; larvae are herbivorous, consuming algae, organic debris, and plant tissue (NatureServe 2026, NDOW 2022). The advertisement call is a high-pitched trill (NDOW 2022).

Egg deposition occurs among gravel, leaves, or sticks, or on mud or clean sand, in flowing or shallow quiet waters of perennial or semipermanent streams or shallow ponds (Dahl et al. 2000). In west-central Arizona, breeding occurs from February to April independent of rainfall and typically lasts only a few weeks each year (NatureServe 2026). In southwestern Utah, breeding peaks in June and may extend into July or August at higher elevations (NatureServe 2026). Individuals may migrate short distances between nonbreeding terrestrial habitats and breeding pools (NatureServe 2026).

The taxonomy of *A. microscaphus* has been subject to revision. The species was formerly treated as a subspecies of *Bufo woodhousii* by some authors, and the genus *Anaxyrus* was split from *Bufo* by Frost et al. (2006), though many references continue to use *Bufo*. Gergus (1998) examined allozyme variation in the *microscaphus* complex and found discrete differences among the three subspecies (*microscaphus*, *californicus*, and *mexicanus*), concluding under the phylogenetic species concept that each should be recognized as a distinct species. The species is synonymized with *Bufo microscaphus* and *Bufo microscaphus microscaphus* in older literature (NatureServe 2026).

Range

The Arizona toad occurs in the southwestern United States in scattered locations across southwestern Utah, southern Nevada, Arizona, and western New Mexico (Price and Sullivan 1988, Sullivan 1993, Gergus 1998, Stebbins 2003, Brennan and Holycross 2006, Ryan et al. 2014). The species is found from the Colorado and Virgin River basins in southern Nevada and southwestern Utah southeast through the lower mountains of Arizona mostly below the Mogollon Rim into the Mogollon Plateau of west-central New Mexico (Nigro and Rorabaugh 2023). Using GBIF records from 2005 to 2025, range extent is estimated to be approximately 208,600 km² (NatureServe 2026). The species is presumed extirpated from its small historical distribution in California (Clark 2011).

Genomic analysis has revealed two genetically distinct groups within the species' range, divided by the Colorado River (Oyler-McCance et al. 2024). The northern group comprises populations in the Virgin River, Beaver Dam Wash, and Meadow Valley Wash drainages of Utah and Nevada, while the southern group encompasses populations in central and southeastern Arizona and New Mexico. Within the southern group, additional substructure exists between lower-elevation western drainages (Bill Williams, Verde, and Agua Fria rivers) and higher-elevation eastern drainages (Salt, Gila, Mimbres, and Rio Grande rivers), with connectivity among populations shown to be facilitated by mesic conditions at higher elevations (Oyler-McCance et al. 2024).

In Nevada, the Arizona toad is restricted to the Meadow Valley Wash, Beaver Dam Wash, and Virgin River drainages and was historically present in Las Vegas Valley, where it is now believed extirpated (NDOW 2022, Bradford et al. 2005). The species has a highly fragmented range within the state, and information on occupied habitats in Nevada is largely lacking (NDOW 2022). Recent eDNA-based detections reported by Stemp and Hossack (2026) provide the first confirmed evidence of Arizona toad presence in Clark County in approximately 40 years, with detections along the Virgin River between the Arizona state line and the confluence with the Muddy River at Lake Mead.

Habitat Characteristics

The Arizona toad is associated with lotic aquatic systems and occupies a variety of riparian habitats from lowland desert washes to higher-elevation pine-oak zones. Habitat includes rocky stream courses, stream corridors bordered by willows and cottonwoods, irrigation ditches, flooded and irrigated fields, and reservoirs (Stebbins 2003, Price and Sullivan 1988, Schwaner and Sullivan 2005). The species depends on shallow, perennial river and stream reaches with sandy, open floodplain habitats, and this specificity renders it more sensitive to flow reductions or drying than most other toads in the region (Oyler-McCance et al. 2024). Breeding habitat consists of shallow, low-gradient springs and streams (Schwaner and Sullivan 2005). As smaller isolated wetlands have dried up due to drought and other factors, the species has shifted toward primarily occupying riverine habitat (Driver et al. 2023).

Habitat modeling conducted by Stemp and Hossack (2026) in southern Nevada, northwestern Arizona, and southwestern Utah identified riparian tree and shrub cover, actual evapotranspiration, and stream permanence as the three strongest predictors of suitable habitat, explaining 89 percent of importance in the final model. Habitat suitability increases with increasing riparian tree and shrub cover and increasing stream permanence; streams with spring-time flows around 10 cubic feet per second and actual evapotranspiration values of approximately 350 mm were also predicted to be suitable.

Habitat Suitability Model

Habitat suitability for the Arizona toad in Clark County was modeled by Simandle and Nussear (2025) using an ensemble approach incorporating multiple machine learning algorithms. A model using Clark County vegetation divisions without a buffered area could not be created because there were only two species locations within the defined area; therefore, the final model was developed without Clark County vegetation divisions and with a buffered area. The ensemble model demonstrated strong performance, with a testing area under the receiver operating characteristic curve of 0.9995 (SD = 0.0010) and a TSS of 0.9900 (SD = 0.0205), indicating strong rank discrimination and high thresholded accuracy. The Continuous BI (CBI) was 0.8283 (SD = 0.1286), with presences enriched by approximately 40 times relative to random for suitability values greater than or equal to 0.8.

Four variables contributed most strongly to the ensemble model. The coefficient of variation in winter precipitation (wpcv) was the most influential variable, contributing to all four component algorithms, and indicated that habitat suitability is highest when the coefficient is low, reflecting a more stable winter precipitation environment. The coefficient of variation of minimum temperature (CVMinTemp) was important in one model, with habitat suitability peaking at approximately 2.0. Distance to water (dist2h2o) contributed to three of four models and showed an unexpected pattern in which habitat suitability was lowest near water and increased with greater distance, likely reflecting the distance-to-water layer's focus on larger water bodies and permanent river flows while the species frequents intermittent sources, combined with the concentration of point localities in the extreme northeast of the study area. The first principal component of sand/silt/clay (soil1) also contributed to three of four models, with high habitat suitability at values below -4 and declining asymptotically at higher values.

Highly suitable habitat for the Arizona toad is predicted to occur in northeast Clark County near the Muddy River at Moapa, as well as along the extent of the Meadow Valley Wash and the Virgin River within the County (Figure 17; Simandle and Nussear 2025). Although only two species locations were documented within Clark County, the Tule Springs Hills area immediately north of the County is also predicted to be highly suitable habitat, and many additional individuals have been documented in that area. Locality data consisted of 104 records within the buffered modeling area, and spatial thinning reduced the number of localities used for training and testing to 100 records.

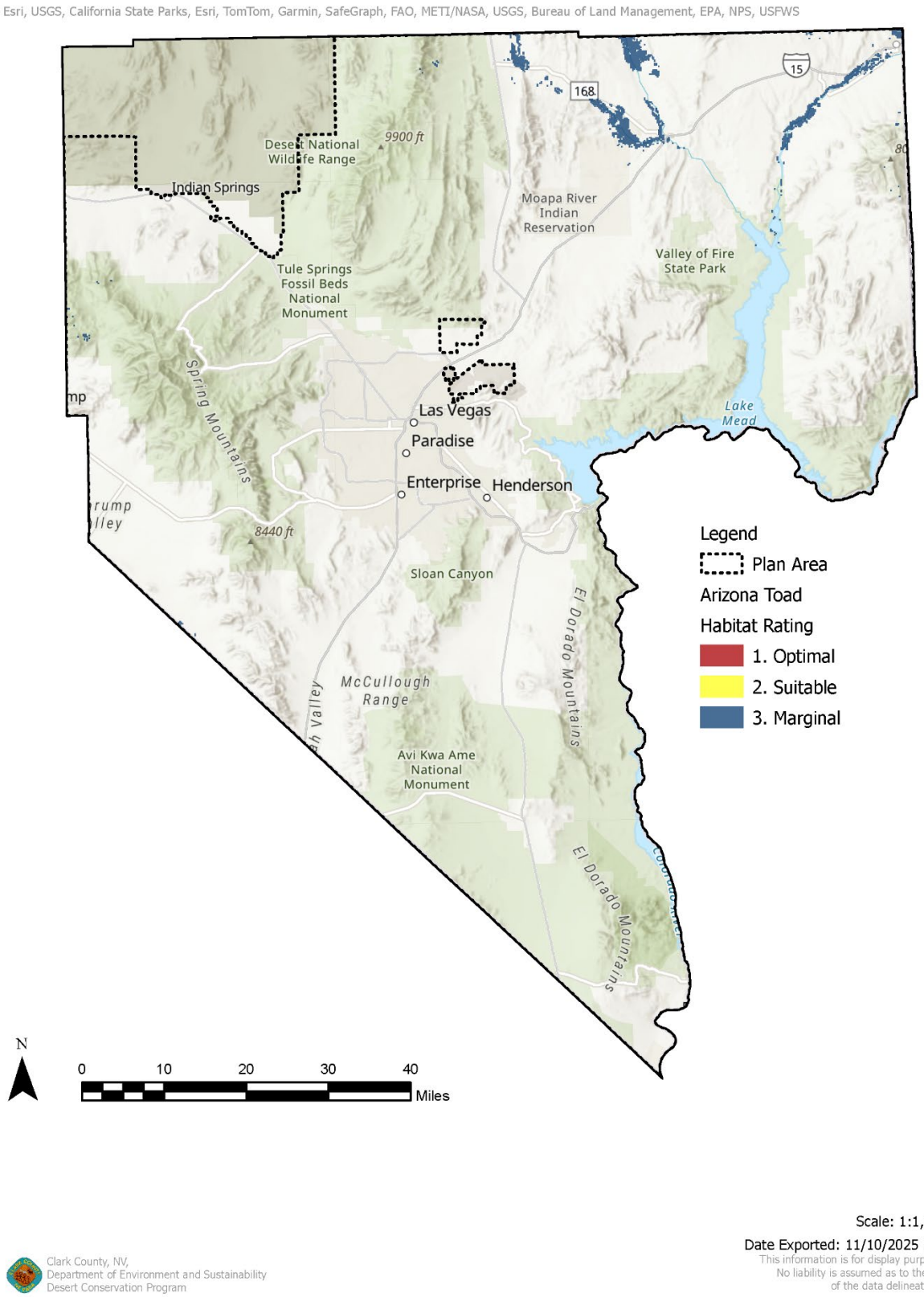

Figure 17. Habitat suitability model for the Arizona toad (*Anaxyrus microscaphus*) in Clark County, Nevada (Simandle and Nussear 2025).

Species Status

Agency/Organization	Status
MSHCP (2000)	None
U.S. Fish and Wildlife Service Endangered Species Act	None[1]
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	None
State of California	None
State of Arizona	Species of Greatest Conservation Need
State of Utah	Species of Greatest Conservation Need
NV Division of Natural Heritage	At Risk
NV Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Presumed Stable
NatureServe Global and NV State Rank	G4 S2
IUCN Red List	Least Concern
CITES	None

[1] The USFWS issued a positive 90-day finding on an Endangered Species Act listing petition in 2015 (USFWS 2015); the species remains unlisted federally but is included in the USFWS FY23 to 27 National Domestic Listing Workplan and is slated for assessment in fiscal year 2026 (USFWS 2023).

The Arizona toad is currently ranked G4 (Apparently Secure) globally by NatureServe (NatureServe 2026), reflecting that while the species retains a broad distribution across the southwestern United States, populations have experienced declines in area of occupancy and abundance. The national status for the United States is N3N4. State rankings reflect greater concern at the regional level: Nevada and Utah are each ranked S2 (Imperiled), while Arizona and New Mexico are ranked S3 (Vulnerable) (NatureServe 2026, NDOW 2022). The species is listed as Sensitive by the BLM in Nevada (NDOW 2022) and is recognized as a Species of Greatest Conservation Need in Arizona and Utah (Oyler-McCance et al. 2024). The COSEWIC does not assign status to this species, as it does not occur in Canada (NatureServe 2026).

On July 11, 2012, the USFWS received a petition requesting that 53 species of reptiles and amphibians, including the Arizona toad (as *Bufo microscaphus microscaphus*), be listed as endangered or threatened and that critical habitat be designated under the Endangered Species Act. Based on review of the petition and cited sources, USFWS issued a positive 90-day finding in 2015 indicating that the petition presented substantial scientific or commercial information suggesting the petitioned action may be warranted (USFWS 2015). The species was included in the USFWS FY23 to 27 National Domestic Listing Workplan and is slated for assessment in fiscal year 2026 (USFWS 2023).

Population Trends

Population trends for the Arizona toad are generally negative, though the rate and extent of decline vary by region. NatureServe (2026) estimates a long-term trend of 30 to 50 percent decline and a short-term trend of 10 to 30 percent decline. The species has likely been extirpated from its small historical distribution in California (Clark 2011). During 2016 surveys in New Mexico, the species was detected at 28 of 90 historical locations (31 percent), with 65 percent of extant sites having low occupancy (NatureServe 2026). Two sites in

New Mexico that were occupied in 2014 were not detected in 2016 and were presumed extirpated (NatureServe 2026). A decades-old survey in Arizona indicated local declines but no obvious major trend (NatureServe 2026).

Between 2013 and 2018, consecutive years of unseasonal flooding or drought in New Mexico were associated with no breeding activity or loss of entire cohorts. Similar patterns were observed in Arizona from 2020 to 2022 (Oyler-McCance et al. 2024). In Nevada, trend may be declining but the rate of decline is unknown; Stebbins (2003) estimated that the species has disappeared from a majority of its historic range rangewide, though populations in Beaver Dam Wash and isolated springs in Meadow Valley Wash may be stable to increasing (NDOW 2022). Global abundance is unknown but presumably exceeds 10,000 adults, with several hundred adults reported along individual stream lengths of 1.0 to 1.5 kilometers in some locations (NatureServe 2026).

Habitat Level Threats

The primary habitat-level threat to the Arizona toad is drought and the associated lack of persistent wetlands (NatureServe 2026, Oyler-McCance et al. 2024). As smaller isolated wetlands dry and local extirpations occur, the species has shifted to primarily occupying riverine habitat (Driver et al. 2023). Riparian degradation occurs through water diversions, dams, channelization, urbanization, and recreational use (NDOW 2022). The species is suffering localized declines where riverine habitats have been dammed or otherwise converted to slow-moving or still-water habitats such as reservoirs, cattle ponds, and golf course ponds (Sullivan and Lamb 1988, Sullivan 1993, Schwaner and Sullivan 2005, Schwaner and Sullivan 2009, Nigro and Rorabaugh 2023).

Climate change is expected to exacerbate these threats by altering hydrology, reducing snowpack, increasing aridity, and increasing the frequency and severity of droughts (NDOW 2022, Oyler-McCance et al. 2024). In Clark County specifically, groundwater pumping activities that lead to declines in seeps and springs, off-highway vehicle use, and construction of water impoundments represent additional habitat-level threats (NDOW 2022). Because genetic connectivity among populations appears to be facilitated by mesic conditions at higher elevations, loss of headwater springs from drought, reduced snowpack, and severe fire may lead to population isolation in the southern portion of the range (Oyler-McCance et al. 2024).

Threats to Species

Hybridization with Woodhouse's toad (*Anaxyrus woodhousii*) is a primary species-level threat to the Arizona toad and was identified as one of the primary threats in the 2015 petition for Endangered Species Act listing (USFWS 2015, Sullivan 1986, Schwaner and Sullivan 2009). Hybridization between *A. microscaphus* and *A. woodhousii* has been documented in Arizona (Sullivan and Lamb 1988, Sullivan 1993), Nevada (Schwaner and Sullivan 2005), and Utah (Schwaner and Sullivan 2009), but apparently not in New Mexico where *A. woodhousii* does not co-occur (Ryan et al. 2017). Hybridization typically occurs after riverine habitats are converted to reservoirs by damming in areas where both species occur, as *A. woodhousii* subsequently moves into the slower-moving or still-water environments favored by the species (Sullivan and Lamb 1988, Sullivan 1993, Wooten et al. 2019).

In Clark County, morphological evidence of potential Arizona toad x Woodhouse's toad hybridization has been observed at multiple locations, particularly at Las Vegas Wash near the Clark County Wetlands Park and at Clark County MSHCP Riparian Reserve Unit, Bunkerville East. Several Woodhouse's toads in these areas display hybrid-like traits including faint eyelid bars, squat parotoid glands, and prominent dorsolateral stripes (Stemp and Hossack 2026). Because environmental DNA methods cannot distinguish hybridized from non-

hybridized individuals (the assay targets maternally inherited mitochondrial DNA), the extent of hybridization in the study area remains uncertain, and genetic analysis of collected buccal swab samples would be needed to resolve this question (Stemp and Hossack 2026).

Nonnative predators, particularly American bullfrogs (*Lithobates catesbeianus*), predatory fish, and crayfish, prey on eggs and tadpoles (NDOW 2022). In Clark County, bullfrogs overlap with a large proportion of the Arizona toad population in the Meadow Valley Wash and Virgin River drainage basin (NDOW 2022). Disease, particularly the amphibian chytrid fungus *Batrachochytrium dendrobatidis*, has been detected in the species in New Mexico, though it has not been clearly associated with mortality to date (Ryan et al. 2014). An unidentified skin fungal pathogen was associated with mortality events at two sites in New Mexico (Ryan et al. 2014).

Conservation and Management

Clark County is at the western extent of the species' range and may support an extant population based on recent eDNA detections along the Virgin River (Stemp and Hossack 2026). No species-specific recovery plan, conservation agreement, or multi-agency working group exists for the Arizona toad comparable to what is in place for, for example, the Amargosa toad or boreal toad in the region. Conservation and management is currently addressed through (1) the pending USFWS species status assessment and Endangered Species Act listing evaluation, (2) BLM sensitive species management on federal lands, (3) State Wildlife Action Plans in Nevada, Utah, Arizona, and New Mexico, and (4) habitat-based protection on NPS and other federal conservation lands.

The following table summarizes the acres of suitable habitat for the Arizona toad within the MSHCP Amendment Plan Area, within the Impact Area, within lands managed for resource conservation, within the existing MSHCP Reserve System, and within MSHCP Amendment Reserve System Additions (Simandle and Nussear 2025). Of the 28,158 acres of suitable habitat within the MSHCP Amendment Plan Area, approximately 5,329 acres (18.9 percent) occur within the Impact Area, and 13,324 acres (47.3 percent) occur within lands managed for resource conservation. Within the MSHCP Reserve System, 329 acres (1.2 percent) of suitable habitat occur in the existing reserve, with no suitable habitat occurring in MSHCP Amendment Reserve System Additions.

Arizona toad (*Anaxyrus microscaphus*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	28,158	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	5,329	18.9%
Suitable Habitat in Lands Managed for Resource Conservation	13,324	47.3%
Suitable Habitat in the existing MSHCP Reserve System	329	1.2%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	0	0.0%

**Simandle and Nussear 2025*

Clark County Survey Data

Historical records indicate the Arizona toad was present in the Las Vegas Valley prior to extensive urban development, with two museum specimens from the 1930s confirming the species in spring-fed habitats that have since been heavily modified (Bradford et al. 2005). Examination of museum specimens in the 1990s verified these historical records as correctly identified Arizona toads. However, extensive amphibian

surveys conducted in the late 1990s and described by Bradford et al. (2005) found no evidence of non-hybridized Arizona toads at historical localities in Clark County, indicating an apparent contraction of the species' historical range. Bradford et al. (2005) concluded that Arizona toads in Las Vegas Valley had been replaced by Woodhouse's toads or hybrids at some locations.

USGS crews surveyed portions of the range during 2019 to 2020 (Tornabene et al. 2026), obtaining 10 verified records of Arizona toad. These surveys observed Arizona toad larvae and metamorphs during July in Lincoln County, Nevada, indicating that summer sampling is appropriate for the species.

The Clark County Desert Conservation Program funded a two-year USGS project conducted during 2024 to 2025 to assess current status and identify potential habitat for the Arizona toad (Hossack and Stemp 2024, Stemp and Hossack 2026). Field crews used two primary detection methods: visual encounter surveys and environmental DNA (eDNA) sampling. The eDNA filters were collected from sites with adequate water and analyzed at Washington State University for four target species: Arizona toad, Woodhouse's toad (*Anaxyrus woodhousii*), red-spotted toad (*Anaxyrus punctatus*), and American bullfrog (*Lithobates catesbeianus*). Surveys were conducted April through July in both years, with 2025 surveys beginning approximately one month earlier than 2024 to better capture ephemeral water availability. In addition to presence and absence data, crews assessed individual toads for hybrid characteristics using a morphological scoring index and parotoid gland measurements. Over the two-year project, crews visited 270 potential sites, conducted 198 visual encounter surveys at 154 sites, and collected 295 eDNA filters from 131 sites.

No Arizona toads were confirmed in Clark County via visual encounter surveys. However, eDNA methods detected Arizona toad DNA at six sites within the county, all along the Virgin River between the Arizona state line and its confluence with the Muddy River at Lake Mead. This represents the first confirmed evidence of the species in Clark County in approximately 40 years. Three of these detections occurred on Clark County-owned or adjacent properties: Bunkerville East Riparian Reserve (2024), Mormon Mesa South Riparian Reserve (2025), and the Electric Avenue property (2025). An additional eDNA detection in Calico Basin at Red Rock Canyon National Conservation Area was considered inconclusive due to a single weakly positive filter at a site geographically isolated from other verified records (Stemp and Hossack 2026). After the 2024 eDNA detection at Bunkerville East, crews revisited the property in 2025 and found the 2024 site dry; Arizona toad was not detected at Bunkerville East in 2025, but was detected at Electric Avenue less than 1 km downstream in an area with extensive slow backwaters and side channels.

Across the two-year survey effort, seven amphibian species were detected in the study area, including Arizona toad, Woodhouse's toad, red-spotted toad (*Anaxyrus punctatus*), American bullfrog, Pacific chorus frog (*Pseudacris regilla*), relict leopard frog (*Lithobates onca*), and canyon treefrog (*Dryophytes arenicolor*). Red-spotted toad was the most commonly detected amphibian species in the study area. Nonnative American bullfrogs were distributed primarily in the northeastern portion of Clark County where more permanent water sources provide suitable habitat (Stemp and Hossack 2026). Morphological evidence of potential Arizona toad x Woodhouse's toad hybridization was observed at multiple locations, and the relationship between hybrid score and parotoid gland ratio was positively correlated across 139 captured individuals.

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Species Accounts
Invertebrates

Monarch Butterfly (*Danaus plexippus*)

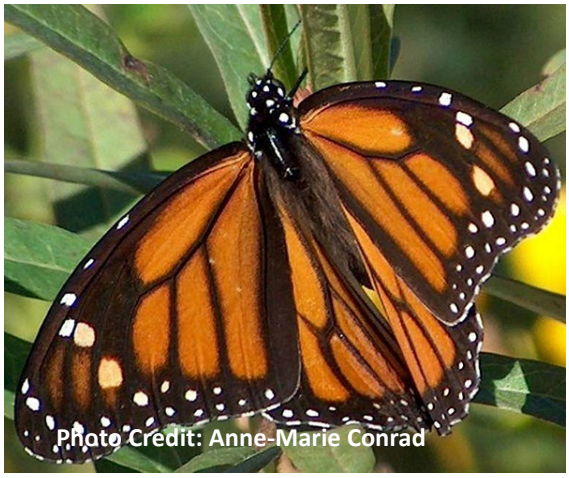
Photo Credit: Anne-Marie Conrad

Photo Credit: Pat Davis

Species Overview

The monarch butterfly (*Danaus plexippus*) is a large, conspicuous butterfly native to North America. Adults are distinguished by bright orange wings bordered with black and marked by a network of black veins, with a double row of white spots along the wing margins (USFWS 2024b). Larvae are black, yellow, and white in color, with long thorax filaments. Adults are sexually dimorphic, with males having narrower wing venation and specialized scent patches on the hindwings. Individuals sequester toxic cardenolides from their larval host plants as a defense against predators, and their bright coloration serves as a warning to predators that consumption can be toxic (USFWS 2024b). Larval monarchs are obligate users of milkweed (*Asclepias* spp. or closely related genera) for feeding, and adults feed on floral nectar from a diversity of blooming species across the breeding and migratory range.

The species consists of two migratory populations in North America, east and west of the Rocky Mountains, along with multiple nonmigratory or resident populations within its native range and introduced populations elsewhere in the world. Migratory populations are typically referred to as *Danaus plexippus* ssp. *plexippus*, while the entire species is referred to as *Danaus plexippus*. Migratory monarchs are present in southern Nevada (NDOW 2022).

Monarch butterfly life history varies by geographic location and is closely tied to the availability of larval host plants and adult nectar resources. Adults lay eggs on milkweed, and larvae emerge after 2 to 5 days. Larvae develop through five instars over 9 to 18 days before pupating into a chrysalis; adults eclose 6 to 14 days later. Breeding-generation adults typically live 2 to 5 weeks, whereas migrating and overwintering adults enter reproductive diapause and live 6 to 9 months (USFWS 2024b). Monarchs breed and forage during the summer months throughout the continental United States and begin their overwintering migration from August to October. Monarch butterflies typically arrive in mid-October at overwintering sites along the California coast and remain until late February or March (Jepsen et al. 2015). Data from tagged monarchs indicate that individuals in Nevada migrate to overwintering sites in California (USFWS 2024b).

Range

The monarch butterfly is native to North America, with a range that has expanded through human-assisted dispersal to 90 countries, islands, and island groups, including parts of Central and South America, Australia, New Zealand, and islands of the Pacific and Caribbean (USFWS 2024b). Despite this global distribution, more

than 90 percent of monarchs worldwide continue to live and migrate within their native North American range. The migratory North American populations are separated by the Rocky Mountains. The eastern population breeds across a vast area east of the Rockies from central Canada south into Mexico and overwinters in dense clusters on oyamel fir (*Abies religiosa*) trees in mountainous regions of central Mexico. The western population breeds west of the Rockies and overwinters in tree groves along the coast of California and into northern Baja California, Mexico, as well as at a few inland sites in the Saline Valley of California (USFWS 2024b).

Western monarchs overwinter in groves populated by a variety of tree species, including blue gum eucalyptus (*Eucalyptus globulus*), Monterey pine (*Pinus radiata*), and Monterey cypress (*Hesperocyparis macrocarpa*). These groves provide the specific microclimate conditions, including indirect sunlight, wind protection, moisture sources, and moderate temperatures, that overwintering monarchs require (USFWS 2024b). Data from monarchs tagged in the southwestern states in the fall suggest that those in Nevada migrate to California, those in New Mexico migrate to Mexico, and those in Arizona migrate to either Mexico or California (USFWS 2024b).

Within Nevada, monarchs occur during the summer breeding season, preferring moist areas such as meadows, riparian areas, springs, and anthropogenic habitats containing milkweed and water sources. Nevada supports breeding sites only and is not known to support any overwintering sites. Range-wide modeling of breeding and milkweed habitat across the seven westernmost states identifies northern Nevada as one of several areas with concentrations of potentially highly suitable habitat, alongside California's Central Valley, southern Idaho, eastern Washington, southern Arizona, and portions of Oregon and Utah (Dilts et al. 2018). In southern Nevada, documented breeding activity in the Mojave Desert near Lake Mead represents one of the few known inland breeding locales for the western population (Morris et al. 2015). In Clark County, monarchs have been documented across a range of locations associated with milkweed occurrences, including the Spring Mountains, Pahrump Valley, Gold Butte, and the Muddy Mountains (Ironwood Consulting 2023).

Habitat Characteristics

Monarch butterflies require three distinct habitat types throughout their annual life cycle: breeding habitat containing milkweed host plants, migratory habitat providing nectar resources along migration routes, and overwintering habitat with specific microclimate characteristics (USFWS 2024b). Breeding habitat requires healthy and abundant milkweed for oviposition and larval consumption, embedded within a diversity of blooming nectar plants that provide resources for adults. In western North America, nectar and milkweed resources are often associated with riparian corridors, and milkweed may function as a principal nectar source for monarchs in arid regions. The correct phenology, or timing, of both monarchs and their host and nectar plants is critical for monarch survival, as is the spatial arrangement of habitat patches on the landscape.

Overwintering habitat, which occurs outside of Nevada, is distinguished by specific abiotic and biotic conditions. Western overwintering groves occupy areas typically within approximately 1.47 miles (2.37 kilometers) of the coast, which provides a mild winter climate (USFWS 2024b). The structure and location of these sites provide indirect sunlight, moisture for hydration, defense against freezing temperatures, and protection from strong winds. This species prefers overwintering habitat comprised of a relatively dense grove of trees with some understory, located near water and nectar sources and protected from wind by topographic landforms or trees (Sakai and Calvert 1991). Winter roost sites are often on south-, southwest-,

or west-facing slopes, which may provide more favorable temperature regimes and wind protection (Leong et al. 2004).

Monarchs occurring in Nevada use breeding and migratory habitat only. In Clark County, suitable breeding habitat is generally associated with mid-elevation areas that support milkweed and nectar resources, with suitability declining in low-elevation valleys and at the highest elevations (Simandle and Nussear 2025). Riparian corridors, springs, seeps, and mesic washes supporting milkweed and flowering plants provide the core breeding and migratory resources for monarchs in the County.

Habitat Suitability Model

Simandle and Nussear (2025) developed a habitat suitability model for the monarch butterfly across Clark County using a stacked ensemble approach that combined outputs from multiple algorithms, including generalized boosted regression (gbm), maximum entropy (MaxEnt), and random forest (rf). Input variables included terrain aspect, slope, the coefficient of variation of minimum temperature, maximum vapor pressure deficit, winter precipitation and its coefficient of variation, soil pH, silica index, gypsum content, distance to water, a separately modeled milkweed habitat suitability layer, and Clark County vegetation divisions. The milkweed suitability layer was itself modeled using the same workflow and species occurrence records, and was then incorporated as a predictor of monarch habitat suitability. The model was built using occurrence records from within the buffered modeling area, which were spatially thinned to reduce sampling bias.

The ensemble model performed strongly. The version incorporating Clark County vegetation divisions produced testing Area Under the Receiver Operating Characteristic Curve and TSS values of 1.00, and a testing BI of 0.90, indicating that predicted suitability values reliably track observed occurrence patterns (Simandle and Nussear 2025). The continuous BI profile indicates that once predicted suitability exceeds approximately 80 percent, observed presences occur up to 50 times more often than expected by chance. Milkweed habitat suitability was consistently among the most influential predictors across all constituent models, reflecting the obligate dependence of monarchs on milkweed as a larval host plant; monarch habitat suitability tracks milkweed suitability closely, with higher milkweed suitability corresponding to higher monarch suitability. Other influential variables included terrain aspect (with suitability highest on northeast-facing slopes and lowest on south- and west-facing aspects), the coefficient of variation of winter precipitation (with suitability rising sharply when the coefficient exceeded approximately 0.7), the silica index, and the coefficient of variation of minimum temperature (Simandle and Nussear 2025).

Areas of high predicted habitat suitability are somewhat broadly distributed across Clark County, with the highest-suitability habitat generally occurring at mid-level elevations; habitat suitability is low in valleys and lowlands and also low at the highest elevations (Simandle and Nussear 2025). A concentration of highly suitable habitat occurs around the southeastern periphery of the South McCullough Mountains, with additional high-suitability habitat predicted north of the Muddy Mountains and near the Muddy River at Overton. Moderately suitable habitat is distributed broadly across the remainder of the County. See Figure 18 for the monarch butterfly habitat suitability model for Clark County.

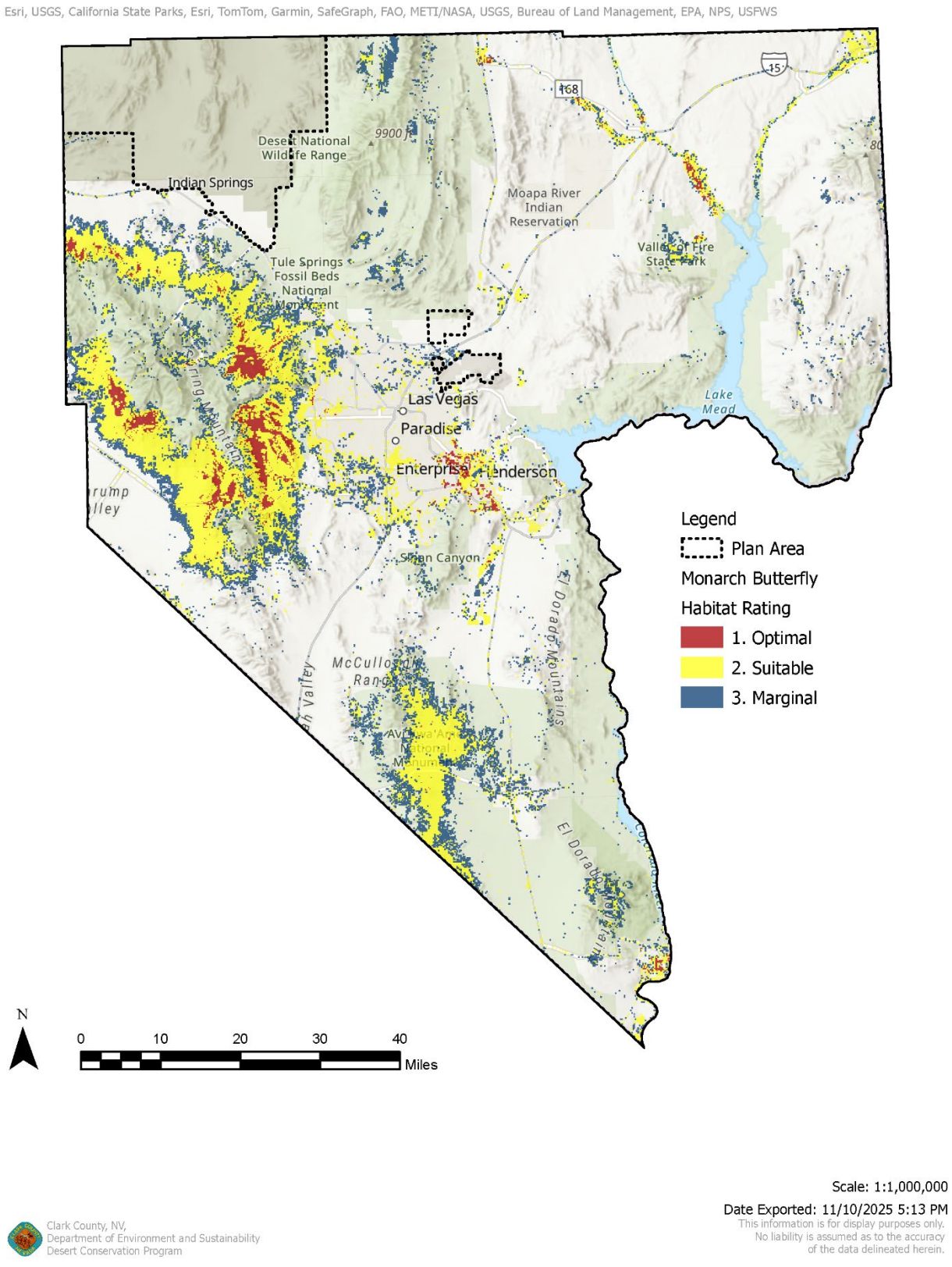

Figure 18. Habitat suitability model for monarch butterfly (*Danaus plexippus*) in Clark County, Nevada (Simandle and Nussear 2025).

Species Status

Agency/Organization	Status
MSHCP (2000)	None
U.S. Fish and Wildlife Service Endangered Species Act	Proposed Threatened
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	No Status
State of California	No Status
State of Arizona	No Status
State of Utah	Species of Greatest Conservation Need
NV Division of Natural Heritage	At Risk[1]
NV State Wildlife Action Plan	Species of Greatest Conservation Need[1]
NV Climate Change Vulnerability Index	Not Evaluated
NatureServe Global and NV State Rank	G4 S3
IUCN Red List	Least Concern
CITES	None

[1] Designation is at the subspecies level of monarch butterfly, *Danaus plexippus plexippus*.

The migratory monarch butterfly does not currently have protections at the federal level. On December 12, 2024, the USFWS published a proposed rule to list the monarch butterfly as a threatened species with protective regulations under section 4(d) of the Endangered Species Act (Act) and to designate approximately 4,395 acres of critical habitat in seven coastal California counties used by the western migratory population for overwintering (89 FR 100662). No critical habitat was proposed in Nevada, as the proposed designation is limited to overwintering groves. The original comment period, which closed March 12, 2025, was reopened through May 19, 2025 (90 FR 12694). A final listing determination has not yet been made. USFWS determined that the monarch butterfly is likely to become an endangered species within the foreseeable future due to the ongoing impacts of loss and degradation of breeding, migratory, and overwintering habitat; exposure to insecticides; and the effects of climate change (USFWS 2024a, 2024b).

Listing petition history for monarch butterfly began on August 26, 2014, when USFWS received a petition to list the species as threatened. A 90-day finding published on December 31, 2014, determined that the petition presented substantial information that listing may be warranted (79 FR 78775). On December 17, 2020, USFWS published a 12-month finding that listing was warranted but precluded by higher-priority actions (85 FR 81813), and monarch butterfly remained designated as a candidate species in annual candidate notices of review in 2022 and 2023 prior to the 2024 proposed listing rule (USFWS 2024b).

The Nevada State Wildlife Action Plan (NDOW 2022) lists monarch butterfly as a Species of Greatest Conservation Need, but this designation does not prescribe specific conservation actions or prohibit take. NatureServe assigns the monarch butterfly a global rank of G4 (Apparently Secure) and a Nevada state rank of S3 (Vulnerable). The IUCN Red List classifies the species as Least Concern, although the migratory subspecies *Danaus plexippus* ssp. *plexippus* has received additional attention due to documented population

declines. The BLM (Nevada) lists monarch butterfly as a Sensitive Species. The species is not listed under the CITES.

Population Trends

Both North American migratory populations of monarch butterfly have experienced significant long-term declines. The eastern North American population, measured by the area of forest occupied by clustered overwintering monarchs in central Mexico, has been generally declining over the last 30 years (USFWS 2024b). The western North American population has been generally declining over the last 27 years despite an increasing number of overwintering sites surveyed (USFWS 2024b).

The western migratory population has undergone significant range-wide decline, an estimated 66 to 91 percent from 2012 to 2022 (Walker et al. 2022). The western overwintering population has been documented at more than 400 sites, but only 109 hosted the species in 2024. The western population has declined more than 74 percent since the late 1990s, from more than 1.2 million to fewer than 200,000 individuals (Western Association of Fish and Wildlife Agencies [WAFWA] 2019). The Species Status Assessment prepared by USFWS (2024a) estimates a 60 to 68 percent probability of extinction for the western population within 10 years under current conditions, rising to approximately 99 percent probability by year 60, with these risks increasing under projected future climate conditions. Both the eastern and western populations are more vulnerable to catastrophic events, such as extreme storms at overwintering sites, due to current low population numbers (USFWS 2024a).

The WAFWA Western Monarch Butterfly Conservation Plan (2019 to 2069) established a near-term population target of 4.5 million wintering monarchs to ensure a self-sustaining population, underscoring the severity of current declines relative to conservation benchmarks (WAFWA 2019). Population trend information specific to Nevada or Clark County is not available, as the state population is not actively monitored or censused. Monarchs occurring in Nevada are progeny of the western migratory population and are therefore subject to the same range-wide trends.

Habitat Level Threats

The primary drivers affecting the health of the two North American migratory monarch populations are loss and degradation of breeding, migratory, and overwintering habitat (USFWS 2024b). Past conversion of grasslands and shrublands to agriculture, combined with widespread herbicide use, has substantially reduced milkweed and nectar resources across the breeding range. More than 860 million milkweed stems were lost in the Midwest between 1999 and 2014, representing a decline of almost 40 percent (USFWS 2024b). While most of this past habitat loss occurred outside of Nevada, it contributes to overall population declines that affect monarchs occurring in Clark County during the breeding and migratory seasons.

Loss of nectar sources has also been implicated as a potential key driver in monarch declines. Climate change, particularly drought, is expected to affect the availability of nectar sources, especially in the western population and in the migratory bottleneck through Mexico and into Texas for the eastern population (USFWS 2024b). In the western United States, drought and warming temperatures are predicted to reduce the availability and quality of both breeding and migratory habitat.

Overwintering habitat in California, although outside of Clark County, is essential to the annual life cycle of western monarchs that breed in Nevada. Since the 1980s, development has caused the loss of at least 63 known California overwintering sites (USFWS 2024b). Habitat alteration through natural tree senescence, improper grove management, fire, disease and pests impacting roost trees, and drought can all reduce the

suitability of remaining overwintering sites. Habitat loss at the Pacific coastal overwintering sites has follow-on effects on Nevada populations (USFWS 2024b).

Threats to Species

Direct threats to monarch butterfly, including those in Clark County, include habitat loss, pesticide exposure, and drought (USFWS 2024b, NDOW 2022). Insecticides are a threat to monarchs based on their mode of action and the potential for exposure throughout the monarch's range (USFWS 2024b). Monarchs can be exposed to liquid insecticides from direct spray at the time of application, contact with vegetation contaminated with an insecticide, or ingestion of leaves or nectar contaminated with insecticide following a spray. Exposure can occur on the application site or in adjacent areas as a result of insecticide drift. Although monarchs are not typically the target species of these products, they are susceptible to mortality and sublethal effects at product label application rates and field concentration levels. The most widely used classes of insecticides affecting monarchs include organophosphates, pyrethroids, and neonicotinoids (USFWS 2024b).

Fungicides represent an additional, less well-characterized pesticide exposure pathway for monarchs. Laboratory research has shown that larval exposure to the fungicide active ingredients azoxystrobin and trifloxystrobin can reduce adult wing length by approximately 12.5 percent (Olaya-Arenas et al. 2020), a sublethal effect that could compromise the success of fall migrants reaching overwintering grounds. Store-bought milkweed plants sampled from commercial nurseries have been found to carry these same two fungicides on 75 percent of plants at concentrations sufficient to affect wing size (Halsch et al. 2022). Fungicides are also commonly used as synergists with insecticides, and the combined effects of co-occurring pesticide residues on milkweed warrant further investigation.

Climate change affects monarchs both directly and indirectly. Direct effects include impacts on fecundity, mating success, and survival during migration. Laboratory studies indicate optimal temperatures for monarchs range between 81 to 84 °F (27 to 29 °C), with sublethal effects beginning in the 86 to 97 °F (30 to 36 °C) range and an upper lethal thermal limit of 108 °F (42 °C) (USFWS 2024b). Monarchs also cannot complete development at temperatures below 54 °F (12 °C) or above 91 °F (33 °C) (Zalucki 1982). Nighttime respite from elevated daytime temperatures is important for survival; experimental nighttime temperatures of 93 °F (34 °C) paired with daytime temperatures of 100 °F (38 °C) resulted in reduced survival, indicating that cooler overnight conditions are a key factor in monarch tolerance of heat stress (Nail et al. 2015). Temperatures consistently above 91 to 95 °F (33 to 35 °C) are unsuitable for monarchs and may account for their general absence from the southern United States after spring. Given these thermal tolerances, the arid summer climate of southern Nevada and Clark County constrains the timing and extent of monarch breeding activity. High temperatures and drought conditions may be particularly impactful during the crucial spring migration. Climatic niche modeling for the western population also predicts an inland and upslope displacement of suitable overwintering conditions along the California coast under future climate scenarios, although it remains unclear whether monarchs will use these projected upslope areas (Fisher et al. 2018; USFWS 2024a).

Additional threats evaluated in the Species Status Assessment but not identified as key population drivers include disease, parasitism, captive rearing, collection, impacts of tourism at overwintering sites, invasive swallow-wort plants, vehicle mortality, and natural catastrophes (USFWS 2024a). Monarch butterflies occurring in Nevada are progeny of the western migratory population and are subject to these threats throughout their range; habitat loss at Pacific coastal overwintering sites has follow-on effects on Nevada populations.

Conservation and Management

The monarch butterfly's general habitat use and wide distribution provide opportunities for conservation across a broad range of land uses and landowner types. Protection, restoration, enhancement, and creation of milkweed and nectar habitat is a central element of recent monarch conservation strategies (USFWS 2024b). Large-scale planning documents include the Mid-America Monarch Conservation Strategy developed by the Midwest Association of Fish and Wildlife Agencies and the Western Monarch Butterfly Conservation Plan developed by WAFWA (WAFWA 2019). The Western Monarch Butterfly Conservation Plan (2019 to 2069) encompasses Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington, which together comprise the core of the western monarch range; it includes short-term goals to protect and manage overwintering sites in California and to provide a minimum of 50,000 additional acres of monarch-friendly habitat in California's Central Valley and adjacent foothills by 2029 (WAFWA 2019). The Plan also addresses conservation strategies for breeding habitat across the western states, including Nevada.

In early 2020, the Nationwide Candidate Conservation Agreement for Monarch Butterfly on Energy and Transportation Lands (CCAA/CCA) was finalized. Under this agreement, energy and transportation entities provide habitat for the species along rights-of-way corridors across the country (USFWS 2024b).

The Nevada State Wildlife Action Plan (NDOW 2022) identifies monarch butterfly as a Species of Greatest Conservation Need and supports conservation partnerships and voluntary habitat improvement efforts consistent with range-wide goals. Although NDOW does not hold statutory authority to manage monarch butterflies, the agency participates in WAFWA's development of conservation strategies for the species, and NDOW biologists record incidental sightings of monarch adults and larvae during fieldwork (WAFWA 2019). Statewide habitat improvement projects carried out by NDOW that address non-native weeds and pinyon-juniper expansion also benefit monarchs and other pollinators through native habitat enhancement, and NDOW has identified milkweed management on Wildlife Management Areas, cooperative monarch surveys and tagging, and integration of monarch considerations into habitat restoration as future contributions to monarch conservation (WAFWA 2019). The Nevada Natural Heritage Program continues to monitor and provide distributional data for pollinator species of concern, including monarch butterfly (WAFWA 2019). In Nevada, the USFWS has worked with partners including the University of Nevada–Reno and the Xerces Society on tagging, parasite testing, milkweed and breeding-monarch surveys, habitat suitability modeling, and public outreach (WAFWA 2019).

Simandle and Nussear (2025) modeled suitable habitat for this species on the basis of winter precipitation, host-plant suitability, and terrain. Of the 419,895 acres of suitable monarch butterfly habitat within the MSHCP Amendment Plan Area, approximately 12,606 acres (3.0 percent) occur within the Impact Area. A total of 282,441 acres (67.3 percent) of suitable habitat are located within lands managed for resource conservation. Within the MSHCP Reserve System, 2,837 acres (0.7 percent) of suitable habitat occur in the existing reserve, with an additional 20,825 acres (5.0 percent) in MSHCP Amendment Reserve System Additions.

Monarch butterfly (*Danaus plexippus*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	419,895	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	12,606	3.0%
Suitable Habitat in Lands Managed for Resource Conservation	282,441	67.3%

Monarch butterfly (*Danaus plexippus*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the existing MSHCP Reserve System	2,837	0.7%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	20,825	5.0%

*Source: Simandle and Nussear 2025.

Clark County Survey Data

Monarch butterfly is understudied in Nevada, and the state population is not actively monitored or censused. No systematic surveys for monarch butterfly have been conducted specifically within Clark County by state or federal agencies. Citizen-science data are available from iNaturalist, which recorded 28 monarch observations in Clark County in 2024 (iNaturalist 2024). At the regional scale, the Xerces Society's Western Monarch Milkweed Mapper compiles public and agency reports of monarch and milkweed occurrences across 11 western states and, together with on-the-ground surveys conducted in Nevada and other western states, provided the occurrence data used by Dilts et al. (2018) to develop the first range-wide habitat suitability models for monarch breeding and for native milkweed species in the western United States. Clark County records contribute to this regional dataset and inform broader prioritization of breeding, migratory, and restoration habitat in the western monarch range.

Rare plant surveys conducted by Ironwood Consulting to identify potential habitat for monarch butterfly in Clark County recorded incidental observations of four distinct *Asclepias* species. These milkweed occurrences were located in the Spring Mountains, Pahrump Valley, Gold Butte, and the Muddy Mountains (Ironwood Consulting 2023). Milkweed presence is a critical indicator of potential monarch breeding habitat, given the obligate dependence of larval monarchs on *Asclepias* species, and these data inform both the habitat suitability modeling conducted by Simandle and Nussear (2025) and future monarch conservation planning in Clark County.

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Mojave Poppy Bee (*Perdita meconis*)

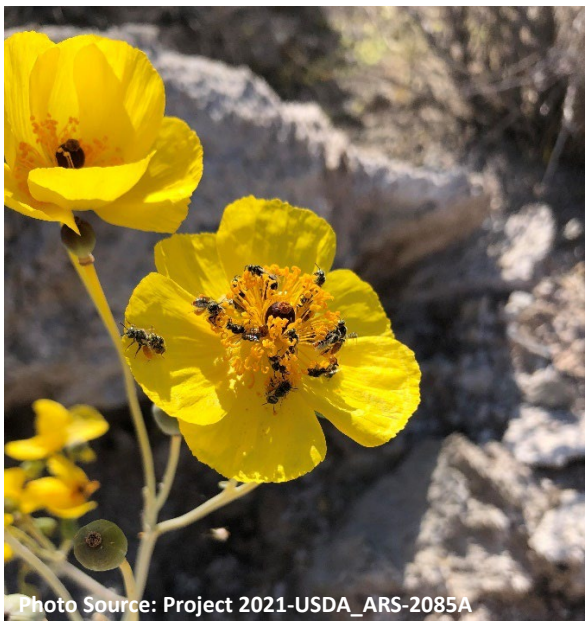
Photo Source: Project 2021-USDA_ARS-2085A

Species Overview

The Mojave poppy bee (*Perdita meconis*) is a small, pollen-specialist bee strongly associated with flowers in the genera *Arctomecon* and *Argemone* in the eastern Mojave Desert. This diminutive bee is between 4.5 and 7 mm long, with a forewing length of 4 to 5 mm. This species features sexual dimorphism characterized by females with pale yellow head markings, and males with dark green heads. Mojave poppy bee is of conservation interest because of its small home range and reliance on rare host plants (Cornelisse 2018). This species may remain dormant for up to three years, presumably as an adaptation to boom-and-bust cycles of host plant availability (WRA 2020).

Range

The Mojave poppy bee historically occurred across portions of southeastern California, southern Nevada, southern Arizona, and southwestern Utah, where its host plants in the genera *Arctomecon* and *Argemone* occur on gypsum-derived soils and other specialized substrates in the eastern Mojave Desert. The species is now extirpated from most of this historic range. In Nevada, the Mojave poppy bee is currently restricted to Clark County, where it is associated with gypsum outcrops and desert scrub habitats that support populations of its obligate host plants. Within Clark County, the species is known from seven sites corresponding to five distinct occurrences north of Lake Mead (Portman et al. 2019). Survey data indicate that the current distribution extends from Sandy Valley on the western edge of Clark County through the Muddy Mountains and several isolated occurrences on the south shore of Lake Mead (U.S. Department of Agriculture 2024).

Habitat Characteristics

The Mojave poppy bee is a strict habitat specialist restricted to undisturbed eastern Mojave Desert sites that support its obligate host plants in the genera *Arctomecon* (bear poppies) and *Argemone* (prickly poppies) (Cornelisse 2018, NatureServe 2026). Within Clark County, the species is most strongly associated with the Las Vegas bear poppy (*Arctomecon californica*), a short-lived perennial endemic to gypsum-derived soils (U.S. Department of Agriculture 2024). Suitable habitat typically occurs on gypsum outcrops and gypsiferous badlands at lower to mid elevations, where patches of dense host plants are interspersed with open bare ground that provides nesting substrate. As a ground-nesting solitary bee in the family Andrenidae, *Perdita meconis* requires open patches of friable, gypsum-rich soil for excavation of brood nests (NatureServe 2026).

Because of the bee's small body size and short foraging distances typical of solitary bees, nesting habitat is expected to occur in close proximity to host plant populations (NatureServe 2026). Adult activity is tightly linked to the flowering phenology of host plants, and adults are typically active in April following winter rains that induce poppy bloom (NatureServe 2026).

Seasonal and daily activity patterns further define suitable habitat use. In contrast to most *Perdita*, which are active throughout the middle of the day, *P. meconis* forages primarily in the early morning, with the onset of activity shifting earlier as the season progresses; by early May, foraging on *A. californica* may begin as early as 6:30 to 7:00 a.m., with visitation rates declining through mid-morning and little to no activity observed after noon (U.S. Department of Agriculture 2024). This atypical early-morning foraging pattern is synchronized with floral anthesis in *A. californica*, which occurs before dawn (U.S. Department of Agriculture 2024). Evidence strongly suggests that the species can remain dormant as an immature in its ground nest for multiple years (at least three years) under drought conditions, a life-history trait that allows it to persist through boom-and-bust cycles of host plant availability (U.S. Department of Agriculture 2024).

Habitat Suitability Model

Habitat suitability for the Mojave poppy bee in Clark County was modeled by Simandle and Nussear (2025) using an ensemble species distribution model that combined generalized additive models, generalized boosted models, maximum entropy, and random forest algorithms. Two model variants were produced: one that incorporated Clark County vegetation divisions and was constrained to the county, and a second that excluded vegetation divisions and included a buffered area around the county. Both models performed strongly, with testing area under the receiver operating curve values of 1.0000 and true skill statistic values of 1.0000, and continuous BI values indicating that observed presences were concentrated in high-suitability bins far more often than expected by chance (Simandle and Nussear 2025). Locality data used for modeling consisted of 486 records within the buffered modeling area, which were spatially thinned to 31 to 36 records to reduce clustering effects (Simandle and Nussear 2025).

The most influential predictors of suitable habitat for the Mojave poppy bee were soil gypsum content, the coefficient of variation in minimum temperature, maximum vapor pressure deficit, the coefficient of variation in winter precipitation, and a soil silica index (Simandle and Nussear 2025). Habitat suitability increased steeply with soil gypsum content, reaching a maximum at gypsum values of approximately 8 to 18 and remaining elevated above that range. Suitability peaked at intermediate values of the coefficient of variation in minimum temperature and declined sharply at higher values, while suitability increased with maximum vapor pressure deficit up to approximately 35 hectopascals and remained elevated above that threshold. Highly suitable habitat is predicted to occur primarily in northeastern Clark County at lower to mid elevations, extending from Rainbow Gardens northeast to the southern periphery of the Virgin Mountains, with smaller areas of highly suitable habitat east of the Bird Spring Range and along the southern shore of Lake Mead near the Big Gypsum Ledges (Figure 19; Simandle and Nussear 2025). High-elevation areas of Clark County lack suitable habitat for the species.

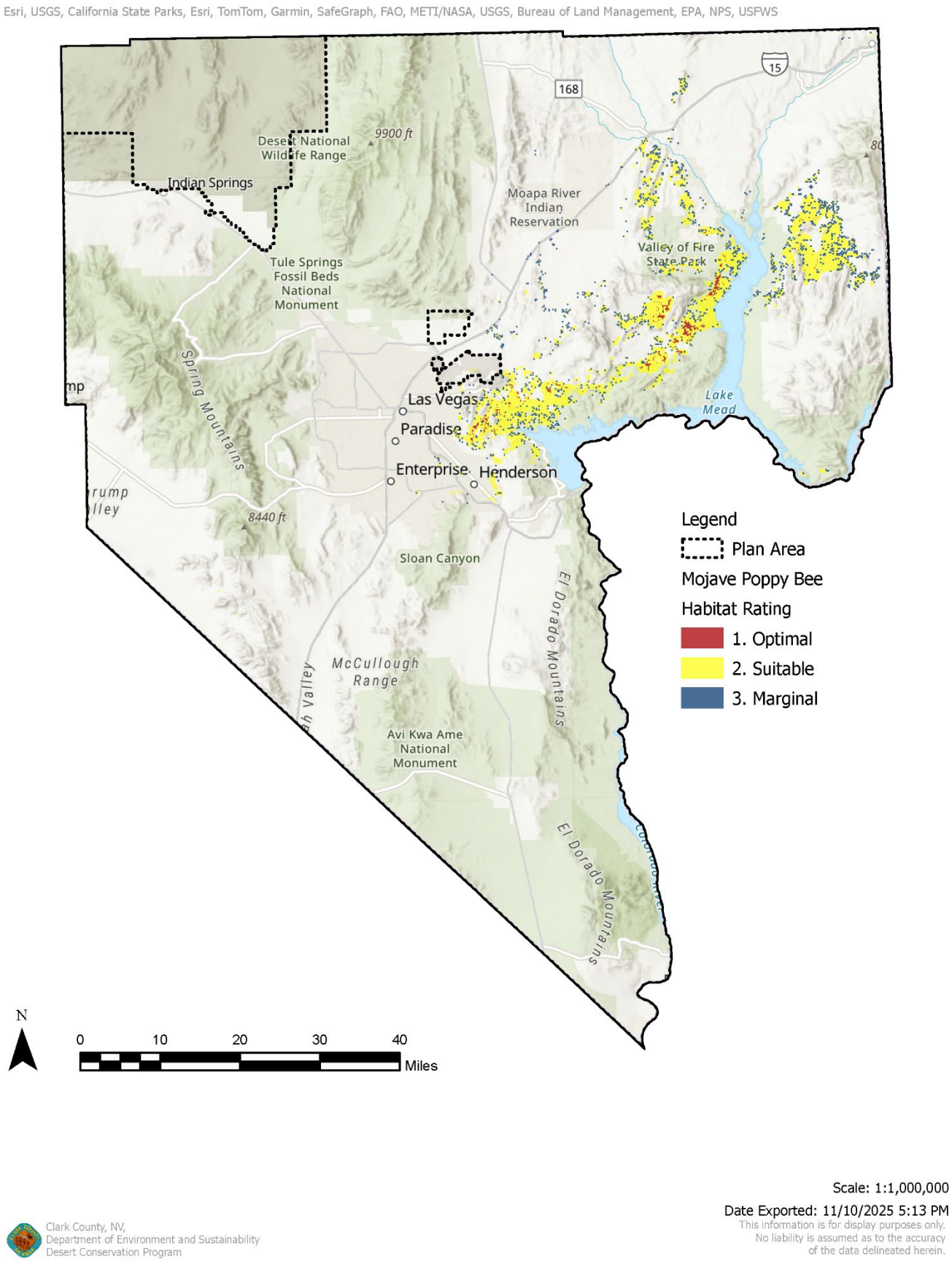

Figure 19. Habitat suitability model for Mojave poppy bee (*Perdita meconis*) in Clark County, Nevada (Simandle and Nussear 2025).

Species Status

Agency/Organization	Status
MSHCP (2000)	None
U.S. Fish and Wildlife Service Endangered Species Act	None[1]
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	None
State of California	None
State of Arizona	None
State of Utah	Species of Greatest Conservation Need
NV Division of Natural Heritage	At Risk
NV Wildlife Action Plan	Species of Greatest Conservation Need
NV Climate Change Vulnerability Index	Not evaluated
NatureServe Global and NV State Rank	G2 S1
IUCN Red List	None
CITES	None

[1]The USFWS found that this species listing may be warranted and has initiated a status review (USFWS 2023).

NatureServe assigns the Mojave poppy bee a global rank of G2 (imperiled) and a Nevada state rank of S1 (critically imperiled), reflecting the species' extremely limited range and small number of known occurrences (NatureServe 2026). The Nevada State Wildlife Action Plan (NDOW 2022) identifies the species as a Species of Greatest Conservation Need. USFWS has identified this species as a candidate for listing under the Endangered Species Act and has initiated a status review (USFWS 2023). The Nevada Division of Natural Heritage lists the species as At Risk. Population trends are not well quantified, but the restricted range and reliance on rare host plants suggest the species remains vulnerable to further decline.

Population Trends

Quantitative population trend data for the Mojave poppy bee are limited, but available information indicates substantial long-term decline accompanied by high interannual variability in detectability. NatureServe (2026) estimates a long-term range-wide decline of greater than 50 percent, noting that the species has been lost from much of its historical range across southwestern Utah, southeastern California, and northwestern Arizona, and is now extant at approximately seven sites corresponding to five element occurrences in Clark County, Nevada. A range-wide survey of 86 potential sites across the historical range detected the species at only a small fraction of locations (Griswold et al. 2005, as cited in NatureServe 2026). In southern Utah, extirpation of the species coincided temporally with the arrival of Africanized honey bees (Tripodi et al. 2019), and the Utah population is now considered extirpated (NatureServe 2026).

The short-term population trend within Clark County is characterized by NatureServe (2026) as relatively stable, with fewer than 10 percent change reported across documented sites between 1995 and 2017 (Portman et al. 2018). However, survey results from 2020 to 2023 demonstrate that apparent stability at the regional scale masks substantial local and interannual variability. Multiple *Perdita meconis* were detected at 25 sites in 2023, whereas only two individuals were detected across all sites surveyed in 2022 despite equivalent survey effort (U.S. Department of Agriculture 2024). These fluctuations are consistent with a life-history strategy involving multi-year diapause during unfavorable conditions and rainfall-triggered emergence

(U.S. Department of Agriculture 2024). Local declines have also been documented; the Rainbow Gardens subpopulation, which supported abundant *P. meconis* in 2020, has not been detected in the last three years, coincident with severe declines in the host plant *Arctomecon californica* at that site (U.S. Department of Agriculture 2024). More than a third of documented host plant populations declined so severely between 2020 and 2023 that no Mojave poppy bees were detected, underscoring the dependence of population persistence on host plant availability (U.S. Department of Agriculture 2024).

Habitat Level Threats

The Mojave poppy bee faces threats from habitat degradation, habitat fragmentation, loss of pollinator mutualism, loss of genetic diversity, invasive species, and climate change. Habitat degradation and fragmentation occur as the result of cattle grazing, urbanization, off-highway vehicle recreation, and mining activities. Due to its small home range and reliance upon the genera *Arctomecon* and *Argemone*, the species is especially vulnerable to impacts on host plant populations. Its host plants are gypsophile or gypsovag species and are therefore imperiled by proposed gypsum mining developments. Gypsum soils are especially attractive to off-highway vehicle recreation around Lake Mead National Recreation Area and are disproportionately impacted by this activity. Cattle grazing may diminish the pool of available floral resources, which reduces habitat value. Grazing may also directly remove host plants from the landscape (Cornelisse 2018, Portman et al. 2019). Invasive species such as Africanized honeybee (*Apis mellifera ligustica*) pose a direct threat to Mojave poppy bee through competition for host plant pollen. Africanized honeybees may also transmit pathogens such as Varroa mites and Black Queen Cell virus (NatureServe 2026). Climate change may exacerbate the frequency of drought and arid conditions, leading to greater stochasticity of host plant availability (WRA 2020).

Threats to Species

Direct threats to the Mojave poppy bee include predation, competition and potential pathogen transmission from invasive Africanized honey bees, and demographic consequences of population stochasticity and dormancy mismatch. Crab spiders (family Thomisidae) that match the color of *Arctomecon californica* petals and wait in ambush are the most frequently observed direct predators of adult *P. meconis*, and spiders observed at survey sites were documented to double or more in size across the flowering season, indicating substantial feeding on flower visitors (U.S. Department of Agriculture 2024). Clerid beetles were also observed to feed on *P. meconis*, although predation by clerids is considered rare and unlikely to produce population-level effects (U.S. Department of Agriculture 2024). The cleptoparasitic bee genus *Neolarra* is an obligate parasite on *Perdita*, but whether it attacks *P. meconis* is unknown because no nests have been located for the species (U.S. Department of Agriculture 2024).

Invasive Africanized honey bees (*Apis mellifera*) pose a direct threat through competition for host plant pollen and the potential transmission of pathogens such as Varroa mites and Black Queen Cell virus (NatureServe 2026). The extirpation of the Mojave poppy bee from southern Utah coincided temporally with the arrival of Africanized honey bees and has been hypothesized to reflect competitive displacement amplified by livestock grazing, which can force honey bees to concentrate foraging on the flowers preferred by *P. meconis* (Portman et al. 2018, Tripodi et al. 2019). An additional threat arises from the potential for mismatch between host plant phenology and bee emergence cues. Emergence of *Perdita* from extended diapause is believed to be triggered by rainfall and humidity cues (Danforth 1999, as cited in U.S. Department of Agriculture 2024), whereas *A. californica* blooming is triggered by a different suite of environmental cues. Under climate change, increased drought frequency and altered winter precipitation patterns may decouple these cues, producing years in which bees emerge without adequate host plant resources or in which host plants bloom without available pollinators (U.S. Department of Agriculture 2024). Finally, because *P. meconis* persists at only five

known element occurrences in Clark County (NatureServe 2026), the species is vulnerable to demographic and genetic stochasticity inherent to small isolated populations.

Conservation and Management

No species-specific conservation or management plan currently exists for the Mojave poppy bee. However, the species benefits indirectly from existing habitat protections in Clark County. A substantial portion of known occurrences occur within or adjacent to Lake Mead National Recreation Area and Gold Butte National Monument, and many remaining populations are considered to persist in relatively good condition due to habitat protections originally established for the federally threatened Mojave desert tortoise (*Gopherus agassizii*) (Portman et al. 2018). The USFWS has determined that listing of the Mojave poppy bee under the Endangered Species Act may be warranted and has initiated a species status assessment, which may lead to additional regulatory protections (USFWS 2023). Conservation of *P. meconis* is necessarily linked to conservation of its obligate host plants, particularly *Arctomecon californica* (the Las Vegas bear poppy), which is itself the subject of a USFWS species status assessment (U.S. Department of Agriculture 2024). Management actions that maintain large, connected populations of host plants on gypsum soils with minimal disturbance from livestock grazing, off-highway vehicle recreation, and gypsum mining are expected to provide the greatest benefit to the species.

Simandle and Nussear (2025) modeled suitable habitat for the Mojave poppy bee on the basis of winter precipitation, host plant suitability, and terrain. High-suitability habitat is predicted to occur in northeastern Clark County, from Rainbow Gardens northeast to the southern periphery of the Virgin Mountains (Simandle and Nussear 2025). Suitable habitat for the Mojave poppy bee (*Perdita meconis*) within the MSHCP Amendment Plan Area totals approximately 303,529 acres. Of this, 6,519 acres (2.1 percent) fall within the Impact Area. Lands managed for resource conservation encompass 172,079 acres of suitable habitat, representing 56.7 percent of the total suitable habitat within the Plan Area. No suitable habitat occurs within the existing MSHCP Reserve System; however, the MSHCP Amendment Reserve System Additions include 50,171 acres (16.5 percent) of suitable habitat for this species.

Mojave poppy bee (*Perdita meconis*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	303,529	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	6,519	2.1%
Suitable Habitat in Lands Managed for Resource Conservation	172,079	56.7%
Suitable Habitat in the existing MSHCP Reserve System	0	0.0%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	50,171	16.5%

*Simandle and Nussear 2025

Clark County Survey Data

The earliest records of the Mojave poppy bee in Clark County come from reproductive ecology studies of the Las Vegas bear poppy (*Arctomecon californica*) conducted by Tepedino and Hickerson (1996). In those surveys, *Perdita meconis* was not detected at any of four surveyed sites in the Las Vegas Valley (Las Vegas Water District, North Las Vegas Air Terminal, Nellis Air Force Base, and a site north of the intersection of Craig and Donovan Roads), but was present at all nine sites surveyed near Lake Mead, extending from Pabco Road north and east to St. Thomas (Tepedino and Hickerson 1996, as cited in U.S. Department of Agriculture 2024). A subsequent survey of rare bees in Clark County in 1998 expanded the known range of the species to include the extreme northern portion of the county near Coyote Springs (Griswold et al. 1999), and a follow-on survey several years later extended the known range eastward to the Virgin Arm of Lake Mead in what is now Gold Butte National Monument (Griswold et al. 2006). Tepedino and Kuta (1997) documented *P. meconis* at

numerous sites in 1995 but were unable to detect the species at the same sites in 1996, providing early evidence of the strong interannual variability in adult activity that has since become a defining feature of the species' survey record.

Between 2020 and 2021, the BLM funded a two-year survey that documented the Mojave poppy bee at three sites in 2020 (Bitter Springs 1, Rainbow Gardens North, and Restoration), but detected no individuals across the entire 2021 flowering season despite extensive surveys by two field crews (U.S. Department of Agriculture 2024). This presence-to-absence pattern between adjacent years was subsequently mirrored in a two-year survey funded jointly with the Clark County Desert Conservation Program and conducted in 2022 and 2023 (U.S. Department of Agriculture 2024).

The U.S. Department of Agriculture Pollinating Insects Research Unit conducted a comprehensive two-year survey for the Mojave poppy bee in Clark County in 2022 and 2023, visiting 28 locations in 2022 and an additional five locations in 2023 for a total of 33 survey sites (U.S. Department of Agriculture 2024). Survey methods included timed observations of bee visitation to *Arctomecon californica*, net collection of bees at host plants, and assessment of host plant reproductive output. Interannual variation in adult activity was extreme: only two *Perdita meconis* individuals were detected across all sites in 2022, whereas the species was detected in good numbers at 15 sites in 2023, spanning Gold Butte National Monument, the west side of the Virgin River arm of Lake Mead, the area east of Las Vegas near Pabco, and the vicinity of Sandy Valley in the southwestern portion of the county (U.S. Department of Agriculture 2024). In 2023, *P. meconis* and the closely related sibling species *P. robustula* were the dominant flower visitors to *A. californica*, accounting for approximately 86 percent of all visits, whereas in 2022 the combined *Perdita* proportion of visits fell to approximately 1 percent (U.S. Department of Agriculture 2024). These surveys confirmed the continued presence of the Mojave poppy bee at multiple historic sites, documented new occurrences within Gold Butte National Monument, and demonstrated that the species was not detected in recent years at Rainbow Gardens despite historic presence there (U.S. Department of Agriculture 2024). Collectively, the survey results demonstrate a high degree of population stochasticity and interannual variability, which complicates assessment of population status and trends and necessitates multi-year survey designs for meaningful status assessment.

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Species Accounts
Plants

Sticky Ringstem (*Anulocaulis leiosolenus* var. *leiosolenus*)

Photo Credit: Stefanie Ferrazzano, Clark County

Photo Credit: Stefanie Ferrazzano, Clark County

Species Overview

Sticky ringstem (*Anulocaulis leiosolenus* var. *leiosolenus*) is a robust herbaceous perennial in the four o'clock family (Nyctaginaceae), distinguished by a gnarled woody root, thick leathery leaves arranged primarily at the base of the plant, and slender stems bearing conspicuous sticky bands at the nodes from which the common and scientific names are derived (Spellenberg 1993, TNC 2007). The plant produces long, white, tubular flowers that are ephemeral, opening at sunset and closing early the following day. Sticky ringstem flowers and sets fruit in mid-summer, and again in October long after most other herbaceous perennials have ceased flowering (Spellenberg 1993). The white nocturnal flowers are visited by sphingid moths in the Chihuahuan Desert and are likely pollinated by moths in the Mojave Desert as well (TNC 2007). Observations conducted on multiple evenings at two monitoring sites in Clark County during the 2008 flowering season documented a hawkmoth species as the most common visitor to open flowers, with small bees or wasps observed visiting early in the evening and small moths observed throughout the night, supporting the hypothesis that the species is primarily moth-pollinated in the Mojave Desert (Rees 2008). The species exhibits a low seed output reproductive strategy in contrast to many co-occurring gypsophiles that produce large seed crops (Meyer 1987, TNC 2007). Sticky ringstem is described as long-lived, although its specific lifespan has not been quantified.

The genus *Anulocaulis* is endemic to the southwestern deserts of North America and contains five species, four of which are gypsophiles, or plants essentially restricted to gypsum substrates (Meyer 1986, Spellenberg and Wooten 1999, TNC 2007). In Nevada, the genus is represented solely by *A. leiosolenus* var. *leiosolenus*. The taxonomy of the species complex has been the subject of several revisions. The Flora of North America (FNA 2003) recognizes four varieties within *A. leiosolenus* (var. *gypsogenus*, var. *howardii*, var. *lasianthus*, and var. *leiosolenus*), following the treatment of Spellenberg and Wooten (1999); a cladistic analysis by Hernández-Ledesma et al. (2010) provides further support for this treatment. The genus *Anulocaulis* was originally segregated from *Boerhavia* by Standley (1909) on the basis of leaf, perianth, and fruit characters, and the cladistic analysis by Hernández-Ledesma et al. (2010) corroborated *Anulocaulis* as a monophyletic group supported by morphological traits including crenulate leaf margins, obtuse leaf apex angle, and monopodial inflorescence ramification, in combination with leathery-succulent leaves, funnel-shaped perianths, and 10-ribbed fruits (Hernández-Ledesma et al.

2010). The species is also sometimes referred to as Chihuahuan ringstem or southwestern ringstem, reflecting the broad geographic range occupied by the different varieties (NatureServe 2026a, 2026b).

The fruits of sticky ringstem are turbinate, woody pods containing a single large seed, and the morphology of the fruit suggests that dispersal is primarily by gravity (Bangle and Craig 2010). The common and scientific names refer to a sticky band approximately one centimeter wide that is present at the stem nodes; the function of the band is not fully resolved but has been hypothesized to trap floral predators and reduce damage to reproductive structures (Bangle and Craig 2010). A two-year phenological study conducted at three Lake Mead sites (Road 100, Echo Wash, and Valley of Fire) documented a mean flowering duration of approximately 130 days among flowering individuals, with maximum stalk height identified as the only measured morphological predictor of flowering duration; individual plants were observed producing as many as 181 buds and 26 open flowers during a season (Bangle and Craig 2010). Despite this high bud production, only a small proportion of buds progressed to the final fruiting stage, suggesting high attrition between flower initiation and mature fruit production (Bangle and Craig 2010). Initial pollinator observations at these sites identified the white-lined sphinx moth (*Hyles lineata*, reported by the authors as *Celerio lineata*) as the principal nighttime pollinator, with a generalist bee species observed visiting flowers in the early evening and morning (Bangle and Craig 2010), consistent with the hawkmoth-dominated pollinator assemblage observed independently at other Clark County sites (Rees 2008).

Range

Anulocaulis leiosolenus var. *leiosolenus* occurs as two geographically disjunct population centers separated by approximately 350 miles of intervening terrain with no known populations (TNC 2007, NatureServe 2026b). The species occupies a combined global range extent of approximately 200,000 to 2,500,000 square kilometers spanning four states and adjacent Mexico (NatureServe 2026b). The western population center occurs in the eastern Mojave Desert, western Colorado Plateau, and Apache Highlands ecoregions of southern Nevada (Clark County) and northern Arizona (Coconino and Yavapai counties). The eastern population center occurs in the northwestern Chihuahuan Desert of New Mexico (Chaves and Doña Ana counties), western Texas (Culberson, El Paso, Hudspeth, and Presidio counties), and adjacent northwest Chihuahua, Mexico (municipios Guadalupe and Coyame) (Hernández-Ledesma et al. 2010, NatureServe 2026b).

In Nevada, sticky ringstem is restricted to Clark County, where it occurs only in the eastern half of the county (TNC 2007). Known populations occur at Frenchman Mountain, the Black Mountains, Bitter Spring Valley, the Muddy Mountains, and in the Gold Butte area, all north of the Colorado River. The Clark County populations represent the westernmost extent of the species' global distribution. TNC (2007) organized the known Clark County occurrences into eight named population groups: Lava Butte, Gypsum Wash, West Black Mountains, East Black Mountains, Bitter Spring Valley, Overton Arm, Muddy River, and Gold Butte. A ninth nearby population group (Big Gypsum Ledges) occurs in adjacent Arizona on the south side of Lake Mead. The Clark County populations are extremely isolated, and none is known to be abundant (TNC 2007). Representative herbarium collections cited by Hernández-Ledesma et al. (2010) document occurrences on gypsum substrates of the Horse Springs Formation along the Pabco Mine road, near Glendale, on the Las Vegas mesa, and on gypsum flats and knolls near Gypsum Cave southeast of Las Vegas, confirming the long history of botanical documentation in the eastern portion of the county.

Habitat Characteristics

Sticky ringstem is essentially restricted to gypsum outcrops, rolling hills, and terraces embedded within a matrix of Mojave desert scrub (primarily creosote bush–white bursage) and salt desert scrub ecological systems (Niles et al. 1999, TNC 2007). Beyond the Mojave Desert, the species also occurs on calcareous shales and clays (Spellenberg 1993, NatureServe 2026b). The plant is classified as a long-lived perennial gypsophile (Meyer 1986), and in Clark County it occupies a unique gypsum barrens plant community that it often shares with Las Vegas bearpoppy (*Arctomecon californica*). Despite its restriction to gypsum substrates, sticky ringstem is not uniformly distributed on this habitat; Meyer (1986) measured only 14 percent constancy for the species on gypsum sites surveyed in Clark County, indicating that occurrence is patchy even within suitable substrate.

The characteristic vegetation of sticky ringstem habitat is a sparse, mostly herbaceous association of gypsum-tolerant species. Associated taxa typically include Torrey ephedra (*Ephedra torreyana*), desert pepperweed (*Lepidium fremontii*), Parry sandpaper plant (*Petalonyx parryi*), Fremont dalea (*Psorothamnus fremontii*), Las Vegas bearpoppy (*Arctomecon californica*), silverleaf sunray (*Enceliopsis argophylla*), wingseed blazingstar (*Mentzelia pterosperma*), matted crinklemat (*Tiquilia latior*), ladder buckwheat (*Eriogonum insigne*), Palmer phacelia (*Phacelia palmeri*), beautiful phacelia (*P. pulchella*), and hairybeast turtleback (*Psathyrotes pilifera*) (Mistretta et al. 1996, TNC 2007). At its eastern locations in New Mexico, Texas, and Chihuahua, the species occurs with viscid acacia (*Acacia vernicosa*), tobosa grass (*Hilaria* spp.), creosote bush (*Larrea tridentata*), and Torrey yucca (*Yucca torreyi*) (Spellenberg 1993). Studies of co-occurring gypsophiles in Clark County have characterized the gypsum-substrate community as quantitatively distinct from adjacent non-gypsum Mojave Desert vegetation, with common surrounding shrubs such as creosote bush (*Larrea tridentata*), white bursage (*Ambrosia dumosa*), and Nevada ephedra (*Ephedra nevadensis*) absent or greatly reduced on gypsum sites, producing a sparser, more open community than the surrounding desert scrub matrix (Sheldon 1994).

Cryptogamic (cryptobiotic) crusts are strongly associated with the species, often with heavy cover at occupied sites (TNC 2007). These biological soil crusts contribute to the viability of vascular plants by stabilizing soils (Ladyman et al. 1998), increasing germination and seedling success, and releasing essential nutrients such as nitrogen through biological fixation (Harper and Pendleton 1993). Crust communities may also play an important role in regulating soil surface temperatures and retaining soil moisture, both of which are hypothesized to be critical factors in the germination and successful establishment of gypsum-endemic plants (Sheldon 1994, TNC 2007).

In the Mojave Desert, sticky ringstem occurrences range from 373 to 717 meters (1,223 to 2,352 feet) in elevation (TNC 2007). The species typically occupies gentle slopes of approximately four degrees and is not known to occur on slopes exceeding 13 degrees. The majority of sticky ringstem occurrences in the Mojave Desert have north, northeast, east, southeast, or south aspects; western exposures (northwest through southwest) and flat sites are rare to absent (TNC 2007). The species occurs in small outcrops of gypsum soils containing as much as 69 percent calcium sulfate (Niles et al. 1999). These small edaphic anomalies are typically not resolved in existing third-order soil surveys. GIS analyses in Clark County map most sticky ringstem locations on continental sedimentary rocks of Triassic age, with additional occurrences on tufaceous sedimentary rocks, the Moenkopi Formation, the Chinle Formation, Aztec Sandstone, and Quaternary alluvial deposits (TNC 2007). The soil series most commonly associated with the species include Drygyp, Guardian, Baseline, Callville, Badland, Bluegyp, Aztec-Bracken complex, Huevi-Cheme, and Huevi-Hiller associations. Across the broader range of the variety, Hernández-

Ledesma et al. (2010) describe occupied substrates as small to steep hillsides or flat ground with alluvium, gypsum, limestone, rocky, slate, or clay soils, at elevations from 400 to 1,200 meters, and document a rangewide flowering and fruiting period extending from February through October and into December, encompassing the bimodal mid-summer and October phenology reported for the species in Clark County. Soil sampling on never-submerged gypsum substrates at Stewarts Point, an Overton Arm site supporting sticky ringstem and Las Vegas bearpoppy, quantified the distinctive chemistry of these substrates: total sulfur concentrations were approximately nine times greater than at nongypsum shoreline sites, electrical conductivity and inorganic carbon were elevated relative to alluvial soils, and the surface soils fell within the Drygyp–Bluegyp soil association (Engel et al. 2014), consistent with the gypsum-series soils reported for sticky ringstem habitat by TNC (2007). Field observations at long-term monitoring sites established at Road 100, Sunrise Hills, and Valley of Fire within Lake Mead National Recreation Area qualified the TNC (2007) characterization of aspect preference, as the Valley of Fire site is nearly flat yet supports a substantial number of sticky ringstem plants and no aspect preference was evident across the three monitored populations, suggesting that the species' apparent avoidance of western and flat exposures in earlier datasets may partly reflect survey bias rather than a strict habitat requirement (Bangle and Craig 2010).

Habitat Suitability Model

A habitat suitability model for sticky ringstem in Clark County was developed by Nussear et al. (2024) using an ensemble species distribution modeling approach. The model combined multiple algorithms, including generalized additive models, random forests, maximum entropy (MaxEnt), and gradient boosting machines, with model contributions weighted according to their relative performance. Both an environmental-variables-only model and a model that additionally included a vegetation layer were produced. The environmental model demonstrated high overall performance, with area under the curve, Boyce index, and true skill statistic values all indicating strong predictive skill and minimal losses between training and testing data. The version incorporating the vegetation layer produced even higher performance metrics, although its predicted suitable habitat more closely reflected the footprint of the known occurrence localities used to train the model, suggesting possible overfitting (Nussear et al. 2024).

The most influential environmental variables in the model were average minimum temperature, average spring maximum temperature, and soil gypsum content, although relative variable importance varied among algorithms (Nussear et al. 2024). Normalized difference vegetation index amplitude, soil silt content, and slope contributed smaller proportions of model influence. Both models predicted higher habitat suitability in the Muddy River and Moapa area and near Lake Mead, while the vegetation-influenced model showed reduced predicted habitat in the area west of Las Vegas. Sticky ringstem occurrence points were most frequently associated with the North American Warm Desert Scrub and Grassland vegetation macrogroup, followed by the Western North American Cool Semi-Desert Scrub and Grassland macrogroup (Nussear et al. 2024). The sticky ringstem habitat suitability model is shown in Figure 20.

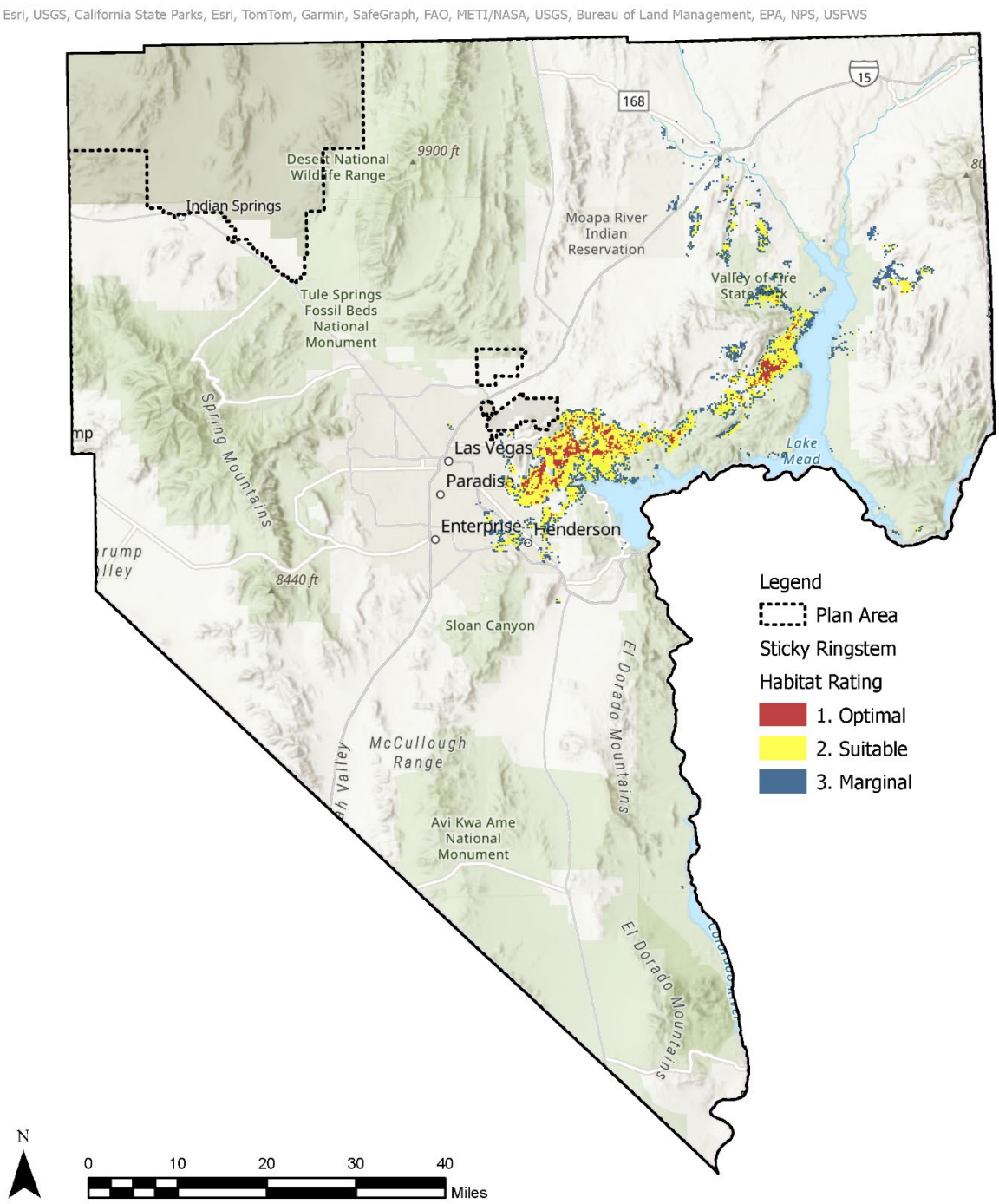

Figure 20. Habitat suitability model for sticky ringstem (*Anulocaulis leiosolenus* var. *leiosolenus*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Covered
U.S. Fish and Wildlife Service Endangered Species Act	None
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	None
State of Arizona	None
NV Division of Natural Heritage	At Risk
NV Climate Change Vulnerability Index	Not addressed
NatureServe Global and NV State Rank	G4T3T4 S2
IUCN Red List	None
CITES	None

Sticky ringstem is not listed under the Endangered Species Act, and no formal petition for listing has been filed. The species is not state-listed as threatened or endangered under Nevada Revised Statutes 527.260 to 527.300, nor is it listed by the states of Arizona, New Mexico, or Texas, where it also occurs (TNC 2007, NatureServe 2026a). USFWS previously considered the species for listing as a Category 2 candidate before that designation was discontinued (Morefield and Knight 1992, Sheldon 1994). The BLM designates sticky ringstem as a Sensitive species in Nevada.

NatureServe most recently reviewed the global status of *A. leiosolenus* var. *leiosolenus* in November 2021, rounding the global rank to T3 (vulnerable) within a parent-species rank of G4 (apparently secure), yielding a combined rank of G4T3T4 (NatureServe 2026b). The Nevada state rank is S2 (imperiled), based on the limited number of known occurrences, restricted distribution within the state, and documented threats from surface-disturbing land uses (NatureServe 2026b). The Nevada Division of Natural Heritage lists sticky ringstem as an At Risk species. The species has not been assessed under the IUCN Red List or CITES and has not been formally evaluated under the Nevada Climate Change Vulnerability Index.

Population Trends

Quantitative data on sticky ringstem population trends are limited throughout the species' range. No systematic demographic monitoring has been conducted specifically for this species in Clark County or elsewhere (TNC 2007). The rangewide trend is presumed stable based on the absence of documented widespread declines (USFWS 2000), but there is insufficient long-term population size information to confirm a trend in Nevada. NatureServe (2026b) reports short-term and long-term population trends as unknown, and global abundance is also reported as unknown.

The limited density estimates available suggest that the species is nowhere abundant within its occupied habitat. Meyer (1987) reported an average density of approximately 0.6 plants per 100 square meters at sites in Clark County where sticky ringstem co-occurs with Las Vegas bearpoppy. Among the named Clark County population groups, the westernmost Lava Butte population group is documented as the largest,

although plants are not numerous; the Bitter Spring Valley population group appears to have the greatest areal extent (Niles et al. 1999, TNC 2007). Undocumented extirpations almost certainly occurred in the Boulder Basin and Overton Arm portions of Lake Mead prior to reservoir inundation. NatureServe (2026b) estimates 21 to 80 element occurrences rangewide for the variety and an area of occupancy of 26 to 125 four-square-kilometer grid cells.

Short-term monitoring results for sticky ringstem in Clark County were obtained between 2008 and 2009 at three permanent plots established at Road 100, Sunrise Hills, and Valley of Fire within Lake Mead National Recreation Area (Bangle and Craig 2010). Across these sites, the number of sticky ringstem individuals appeared to increase from 2008 to 2009, and the authors interpreted the year-over-year change as consistent with a recruitment event at all three monitoring locations in 2009, although the germination cues driving the event could not be identified from the available data (Bangle and Craig 2010). Total vegetative cover at the monitoring sites was under 10 percent in all three sites and was consistent between years, and sticky ringstem cover was also relatively stable across years and similar among sites. The size of individual plants was a significant predictor of bolting success, with smaller plants exhibiting bolting rates ranging from 8 percent (2008 Sunrise Hills) to 76 percent (2008 Road 100) and larger plants ranging from 57 percent to 100 percent depending on site and year; among-site variation in bolting success remained substantial even when plants were stratified by size class, indicating that unmeasured site-level factors also influenced reproductive output (Bangle and Craig 2010). Intermediate levels of local species diversity were associated with the highest numbers of sticky ringstem at Road 100 and Valley of Fire, while species richness alone was not a strong predictor of sticky ringstem numbers at any site (Bangle and Craig 2010). The authors emphasized that two years of data are insufficient to resolve true population trends for a long-lived perennial gypsophile and recommended continuation of the monitoring framework to evaluate trends over time (Bangle and Craig 2010).

Habitat Level Threats

The principal habitat-level threat to sticky ringstem is the destruction, modification, and fragmentation of gypsum substrate habitats, which occupy a small fraction of the Mojave Desert landscape and are spatially concentrated in areas that overlap with urban, industrial, and recreational pressures in Clark County (TNC 2007). Gypsum mining has been identified as the single highest-ranked threat to the species. Gypsum deposits east of Las Vegas are actively mined north of the Rainbow Gardens ACEC, and additional gypsum mining activity has occurred historically on other outcrops used by the species. Gypsum and cryptobiotic surface crusts found on soils supporting sticky ringstem at Bitter Spring Valley, Gypsum Wash, and other occupied sites are easily damaged by vehicle traffic, burros, and humans; once surface crusts are disturbed, the underlying soils are susceptible to accelerated wind and water erosion (Niles et al. 1999, TNC 2007).

Rural and urban development and sprawl associated with the rapid human population growth of the Las Vegas Valley pose additional habitat-level threats, particularly in population groups that overlap private land such as Muddy River and portions of Gypsum Wash (TNC 2007). Utility corridor construction and maintenance, including associated right-of-way grants issued by BLM, have fragmented gypsum habitat and created persistent linear disturbances. Inundation and shoreline fluctuation of Lake Mead have affected habitat in the Overton Arm and adjacent areas, and ongoing low-water conditions continue to expose and re-inundate habitat along the reservoir margins. Primary successional trajectories on formerly submerged shoreline during the prolonged Lake Mead drawdown that began in 1998 have been documented along the Overton Arm and nearby reaches (Engel et al. 2014). Sampling of surfaces last

submerged 3, 6, 9, and 13 years before sampling, together with never-submerged reference sites, showed that exotic species abundance, principally saltcedar (*Tamarix ramosissima*), declined with increasing time since exposure, while native perennial cover increased with surface age; gypsophile species, including *Astragalus preussii* and *Atriplex hymenelytra*, established on the gypsiferous Stewarts Point surfaces but not at nongypsum sites (Engel et al. 2014). These findings suggest that portions of the gypsum substrate exposed by continued reservoir recession may, over time, redevelop habitat conditions suitable for sticky ringstem and associated gypsophiles, although colonization of formerly submerged surfaces by sticky ringstem itself was not documented during that study. Invasive nonnative plant species, including red brome (*Bromus madritensis* ssp. *rubens*), Mediterranean grass (*Schismus* spp.), Sahara mustard (*Brassica tournefortii*), and African mustard (*Malcomia africana*), have increased across the Mojave Desert and elevate the frequency and size of wildfires in a landscape where native gypsum barren communities are not adapted to repeated fire (Brooks and Matchett 2003, Brooks et al. 2003, TNC 2007). Fires can eliminate the sparse native perennial cover and cryptogamic crusts characteristic of sticky ringstem habitat, and in some areas repeated burning may irreversibly convert native communities to nonnative annual grasslands.

Invasive species pressure on gypsum substrates occupied by sticky ringstem may be disproportionate relative to other Mojave Desert soil types. A landscape-scale exotic plant survey of more than 3,000 kilometers of roadsides, trails, and shorelines across Clark County documented African mustard (*Malcomia africana*) on 59 percent of gypsum soil types surveyed, more than twice the 27 percent of all surveyed soil types on which the species was recorded (Abella et al. 2008). Gypsum soils in Clark County constitute the unique rare-plant habitat on which sticky ringstem depends and were not previously considered especially prone to invasion; the disproportionate occurrence of African mustard on these soils raises concern for long-term community integrity at occupied sticky ringstem sites (Abella et al. 2008).

Threats to Species

In addition to habitat-level threats, sticky ringstem faces several direct threats to individual plants and populations within Clark County. Casual off-highway vehicle use and trail proliferation are among the highest-ranked direct threats (TNC 2007). Although off-highway vehicle restrictions apply at Lava Butte and other protected areas, violations of these regulations are commonplace, and existing enforcement is reportedly limited. Off-highway vehicle activity directly crushes individual plants, damages the cryptogamic crusts on which germination and seedling establishment depend, and introduces and spreads invasive plant seeds along disturbance corridors. Legal concentrated recreational use at developed sites within Lake Mead National Recreation Area similarly poses a direct threat where trails, parking, and dispersed camping overlap occupied habitat.

Wild horse and burro management is identified as an ongoing threat, particularly at Lake Mead National Recreation Area where burros may graze sticky ringstem during dry years and where trampling damages gypsum soil crusts (Powell 2004, TNC 2007). Heavy burro damage has been recorded specifically in Echo Wash within the Bitter Spring Valley population group (Niles et al. 1999). More recent surveys in the Bitter Spring Valley area similarly documented potential burro trampling at a sticky ringstem occurrence rated as good-quality and potential recreational foot-traffic trampling at an adjacent good-quality occurrence, reinforcing burro use and dispersed recreation as persistent direct threats at this population group (Ironwood Consulting 2022). Spring 2023 surveys at two newly documented occurrences nearby, in the Bitter Springs North and Echo Hills North survey areas, again recorded off-highway vehicle tracks

running off designated routes and signs of wild burro use as the principal observed impacts on occurrence quality (Ironwood Consulting 2023). Trespass livestock grazing is documented as a lower-intensity threat in some portions of the species' range, and may affect plants directly through consumption and trampling as well as indirectly through soil compaction and weed introduction. The low seed output reproductive strategy of sticky ringstem (Meyer 1987) may render populations particularly sensitive to recruitment failure caused by combined threats operating simultaneously, although this hypothesis has not been quantitatively tested.

Direct herbivory on reproductive structures has also been documented. During a 2007 phenological monitoring study of 21 sticky ringstem individuals at each of three sites in rare plant habitat along Northshore Road, Lake Mead National Recreation Area, researchers observed a substantial amount of chewed or broken stems across all three sites; rabbits were suspected as the cause, although the degree of impact was not quantified (Rees 2007). The phenological monitoring effort continued into a second season in 2008, with permanent nails and aluminum tags replacing pin flags to ensure relocation of the same individuals across years (Rees 2008). Chewed or broken stems, attributed to rabbits, rodents, or possibly wind damage, were also documented across both years of the independent 2008 to 2009 phenology study at Road 100, Echo Wash, and Valley of Fire; plants with damaged stems did not flower, and reduced sample sizes of flowering individuals at each site (n = 6 at Road 100, 10 at Valley of Fire, and 16 at Echo Wash) were directly attributable in part to lack of bolting or stem damage (Bangle and Craig 2010). Detailed tracking of 126 marked buds across the monitored populations found that only approximately 2 percent of buds progressed to the terminal reproductive stage, an attrition rate that, combined with observed stem loss to herbivory, provides mechanistic support for concerns about recruitment limitation (Bangle and Craig 2010). Because sticky ringstem has a low seed output reproductive strategy (Meyer 1987) and flowers and fruits on a restricted set of reproductive branches, routine loss of reproductive branches to herbivory may have disproportionate effects on seed production and recruitment, warranting additional investigation.

Conservation and Management

The species has not received species-specific management actions in Clark County, although populations that co-occur with Las Vegas bearpoppy are protected under measures implemented to conserve that species' gypsum habitat (TNC 2007). Portions of the Lava Butte population group overlap with the Sunrise Valley population of Las Vegas bearpoppy and benefit from associated BLM management. Portions of the Gold Butte and Gypsum Wash population groups overlap with designated ACECs established primarily for other species or resources, and portions of Bitter Spring Valley, Gold Butte, East Black Mountains, and West Black Mountains population groups overlap with designated BLM Wilderness Areas that provide additional protection from surface disturbance. Approximately 70 percent of known data points for the species in Clark County occur on Federal lands managed by BLM (at Lava Butte and Gold Butte) and by the NPS or Bureau of Reclamation (at Bitter Spring Valley, Overton Arm, East Black Mountains, and West Black Mountains) (TNC 2007). The Low Elevation Rare Plant Conservation Management Strategy (TNC 2007) identified seven objectives that address sticky ringstem viability enhancement and threat abatement, including multi-species objectives addressing management of viable populations on Federal lands, abatement of casual off-highway vehicle impacts, and prevention of significant impacts from gypsum mining. No active restoration of disturbed sticky ringstem habitat has been undertaken in Clark County (TNC 2007).

Based on habitat modeling by Nussear et al. (2024), the MSHCP Amendment Plan Area contains approximately 115,646 acres of suitable habitat for sticky ringstem. Of this total, approximately 5,414 acres (4.7 percent) occur within the MSHCP Amendment Impact Area. A total of 75,304 acres (65.1 percent) of suitable habitat falls within lands managed for resource conservation, and 20,778 acres (18.0 percent) are within the MSHCP Amendment Reserve System Additions. Only 1 acre (0.0 percent) of suitable habitat occurs within the existing MSHCP Reserve System.

Sticky ringstem (*Anulocaulis leiosolenus* var. *leiosolenus*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	115,646	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	5,414	4.7%
Suitable Habitat in Lands Managed for Resource Conservation	75,304	65.1%
Suitable Habitat in the existing MSHCP Reserve System	1	0.0%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	20,778	18.0%

*Nussear et al. 2024

Clark County Survey Data

Sticky ringstem was first collected in Nevada in 1938 east of Las Vegas by Percy Train, and subsequent collections in the state have been infrequent (TNC 2007). Holland (1979) included the species on a compiled list of plants for Lake Mead National Recreation Area. Swearingen (1981) documented sticky ringstem in the Muddy Mountains (Overton Arm) during a comprehensive floristic survey of the area. Niles et al. (1999) conducted BLM-sponsored general floristic surveys that recorded approximately 100 plants in Echo Wash within the Bitter Spring Valley population group, along with observations of heavy burro damage at the site.

Surveys for sticky ringstem have historically been sporadic and typically incidental to surveys for other taxa, particularly Las Vegas bearpoppy. Powell (2004) documented 43 sticky ringstem locations at Lake Mead National Recreation Area during concurrent surveys and monitoring for Las Vegas bearpoppy, recording qualitative site-condition information and noting that the species was abundant at some sites, although no quantitative population size estimates were generated. As of the preparation of the Low Elevation Rare Plant Conservation Management Strategy (TNC 2007), no comprehensive status and trend monitoring had been conducted for sticky ringstem in Clark County. The Nevada Natural Heritage Program discontinued tracking the species in the early 1990s but returned it to the Heritage watch list in 2004 (NNHP 2004), which the TNC (2007) authors anticipated would stimulate additional survey information.

Survey and monitoring efforts in the mid- to late 2000s expanded baseline information for the species in Clark County considerably. Targeted surveys conducted in 2005 on gypsum soil habitats at Stewarts Point, Valley of Fire, Echo Wash, and Pinto Valley (old Road 99 and old Road 100) within Lake Mead National Recreation Area, and at Rainbow Gardens on BLM lands, recorded approximately 7,000 sticky ringstem plants across the surveyed areas, representing the most comprehensive single-effort survey for the species documented in Clark County (Bangle and Craig 2010). Between 2008 and 2009, the NPS and Clark County Desert Conservation Program jointly implemented a long-term monitoring program that

established permanent monitoring plots for sticky ringstem at three locations (Road 100, Sunrise Hills, and Valley of Fire) selected using a stratified random approach based on topographic location, accessibility, and patch size (Bangle and Craig 2010). The monitoring design followed the framework developed for Las Vegas bearpoppy and added species-specific data collection for sticky ringstem, including percent cover, number of individuals, status of current-year flower and seed production, number of stems in prior and current years, and number of leaves. Disturbance trails and drainage channels were used as access routes to minimize investigator impact on the sensitive gypsum substrate (Bangle and Craig 2010). Inventories associated with the monitoring program covered historical sites plus an additional 20 percent of area in locations without known occurrences. A companion phenology study of 21 marked individuals at each of three Lake Mead sites (Road 100, Echo Wash, and Valley of Fire) ran concurrently with the monitoring and generated the first quantitative information on flowering duration, bolting success, and reproductive output for the species (Bangle and Craig 2010). The authors noted that three high-priority populations (Muddy River, Gypsum Wash, and West Black Mountains) were not included in the monitoring framework because they occur on private land or are otherwise difficult to access, and that the historical Gold Butte population could not be relocated during the project (Bangle and Craig 2010).

Between April 2009 and May 2010, ICF Jones & Stokes conducted systematic rare plant surveys for ten target species, including sticky ringstem, at 511 four-hectare (approximately ten-acre) plots distributed across 13 geographic units in Clark County (ICF Jones & Stokes 2010). Sticky ringstem was observed four times during the effort: two observations within survey plots and two incidental observations made while traveling to or from survey plots. Evidence of trails and off-highway vehicle use was documented as disproportionately frequent at sticky ringstem and Las Vegas bearpoppy observation locations relative to other target species, which the authors attributed to the open, lightly vegetated, soft-soil character of occupied habitat that facilitates vehicle access (ICF Jones & Stokes 2010).

More recent survey and mapping efforts include SWCA Environmental Consultants rare plant surveys across Clark County, and the compilation of occurrence records used to develop the species distribution model presented in Nussear et al. (2024). In the course of a broader study of plant colonization and soil properties on the Lake Mead shoreline, Engel et al. (2014) independently identified sticky ringstem as a rare plant of management priority co-occurring with Las Vegas bearpoppy on never-submerged gypsum substrates at Stewarts Point, providing a further documented occurrence for the Overton Arm population group. Additional randomized survey effort, comprehensive population-extent mapping, and status-and-trend monitoring at representative populations remain high-priority information needs for the species in Clark County (TNC 2007).

Clark County commissioned targeted rare plant surveys implemented by Ironwood Consulting, Inc. in 2020 and 2021 to ground-truth the 2020 species distribution model and to document occurrences of proposed covered species (Ironwood Consulting 2020, 2021). Spring 2020 survey efforts covered 11,881 acres across 22 general survey locations and documented 46 rare plant occurrence records across 13 of those locations, but autumn-flowering surveys planned for 2020 were not completed because of below-average precipitation during the latter half of the year; sticky ringstem was carried forward as a deferred target for autumn 2021 (Ironwood Consulting 2020).

The 2021 effort combined spring surveys (April 24 to 28) for spring-blooming and perennial species with autumn surveys (October 22 to 30) for late-flowering species and documented sticky ringstem at five occurrences totaling approximately 19.2 acres (7.8 hectares) of occupied area and 90 individuals,

recorded at Mud Wash (one occurrence), Echo Junction (two occurrences), and Bitter Spring (two occurrences) (Ironwood Consulting 2021). Recorded elevations ranged from 464 to 620 meters (1,522 to 2,034 feet). Common associated species across multiple occurrences included Las Vegas bearpoppy, silverleaf sunray, Torrey ephedra, and Fremont dalea. Invasive species were present at relatively low cover at three of the five occurrences, represented by red brome and African mustard. Overall occurrence quality was rated good to excellent; the two occurrences rated as good noted potential trampling from recreational foot traffic at one Bitter Spring site and from wild burros at the second Bitter Spring site (Ironwood Consulting 2021).

Ironwood Consulting continued targeted rare plant surveys for Clark County in spring 2023, conducting fieldwork between April 10 and 22 and between May 1 and 20 across approximately 12,500 acres at 85 upland and wetland survey areas (Ironwood Consulting 2023). Sticky ringstem was documented at two survey areas, Bitter Springs North and Echo Hills North, both representing new occurrence records. The two occurrences together comprised approximately 0.16 acre (0.06 hectare) and 11 individuals, with mean elevations of 581 and 551 meters (1,906 and 1,807 feet), respectively. Both occupied locations had been classified as optimal habitat suitability by the initial species-specific habitat model (Nussear and Simandle 2020) provided by the Desert Conservation Program, providing field validation of the model in the Bitter Spring Valley and adjacent areas. Common associated species recorded across the occurrences included Las Vegas bearpoppy, silverleaf sunray, creosote bush, Parry sandpaper plant, and Fremont indigo bush. Invasive weeds were present at relatively low cover and were restricted to scattered patches under the shade of larger shrubs. Overall occurrence quality varied from poor to good, with the most common impacts attributed to invasive plant cover, observed signs of wild burro use, and off-highway vehicle tracks recorded outside designated routes (Ironwood Consulting 2023).

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Las Vegas Bearpoppy (*Arctomecon californica*)

Photo Credit: Stefanie Ferrazzano, Clark County

Photo Credit: Stefanie Ferrazzano, Clark County

Species Overview

Las Vegas bearpoppy (*Arctomecon californica*) is a short-lived herbaceous perennial in the poppy family (Papaveraceae), endemic to gypsum-derived soils of the eastern Mojave Desert. It is one of three species in the genus *Arctomecon*, all of which are restricted to arid, gypsum-rich substrates of the southwestern United States (Flora of North America Editorial Committee 1997). The species forms a low basal rosette of gray-green, hairy leaves from which leafless flowering stalks emerge in spring, bearing showy yellow flowers with four petals and numerous stamens. The species name *californica* reflects its original description in the 1840s from what was then the Mexican Territory of Alta California, which historically included the area of present-day Las Vegas, Nevada; the species has never occurred within the modern state of California (Welsh et al. 2015; NatureServe 2023).

The species is considered a short-lived perennial that typically lives four to five years and produces multiple flowering events beginning in the second growing season (Thompson and Smith 1997), with individual plants living less than 10 years (NatureServe 2023). Populations are strongly reliant on a persistent soil seed bank, with seeds remaining viable in the soil for 15 years or more, and studies have reported seed germinability extending up to approximately 19 years (Stosich et al. 2022). Reproduction depends heavily on pollination by the specialist Mojave poppy bee (*Perdita meconis*), which visits *Arctomecon* and *Argemone* poppies almost exclusively (U.S. Department of Agriculture 2024). Primary seed dispersal is by wind over short distances of approximately one meter, with secondary dispersal by ants extending to about eight meters (Stosich et al. 2022). Germination is promoted by cold winter temperatures and is most successful following above-average November through March precipitation (Stosich et al. 2022). Demographic monitoring at six Clark County sites in 2008 and 2009 demonstrated that the likelihood of a plant producing seed increases sharply with plant size: individuals in the smallest size class (basal rosette width of approximately 0 to 12 cm) exhibited an estimated seeding probability of

27 to 37 percent, whereas individuals in the largest size class (basal rosette width greater than approximately 20 cm) exhibited seeding probabilities of 92 to 96 percent (Bangle et al. 2010). Plant condition further modified this relationship, with plants in poor condition producing fewer seeds than plants in good condition within the same size class (Bangle et al. 2010).

Las Vegas bearpoppy seeds bear white, lipid-rich appendages known as elaiosomes that facilitate seed dispersal by ants, a process referred to as myrmecochory (Megill 2007; Stosich et al. 2022). This combination of wind and ant dispersal, termed diplochory, concentrates most seeds within one meter of the parent plant while a smaller fraction is moved greater distances by ants, which remove the elaiosomes as a food reward for their larvae and discard the otherwise intact seeds at their nests (Megill 2007). Because primary dispersal distances are several orders of magnitude smaller than the distances between fragmented gypsum habitat patches in the Las Vegas Valley, recolonization of extirpated sites is unlikely to occur through natural seed movement (Stosich et al. 2022).

Range

Las Vegas bearpoppy is a narrow endemic of the eastern Mojave Desert, occurring only in Clark County, Nevada, and adjacent northern Mohave County, Arizona. Its range extends from the vicinity of Las Vegas, Nevada, eastward to extreme northwestern Arizona near Lake Mead and Pierce Ferry (Flora of North America Editorial Committee 1997; NatureServe 2023). The species' range extent is estimated at approximately 6,000 square kilometers, with an area of occupancy of approximately 720 square kilometers based on 180 occupied four-square-kilometer grid cells (NatureServe 2023).

Within Clark County, Las Vegas bearpoppy populations are found throughout the Las Vegas Valley and extend through the northeastern portion of the county, primarily within and adjacent to Lake Mead National Recreation Area. Populations occur at locations including St. Thomas Point, Echo Junction, Bitter Spring, Gold Butte West, Rainbow Gardens, and within Valley of Fire State Park (Ironwood Consulting 2021; NatureServe 2023).

Populations at the eastern edge of the species' range in Mohave County, Arizona, occupy limestone-derived substrates and exhibit distinct morphological and genetic characteristics; these Grand Canyon populations have been described as a potentially undescribed variant of *Arctomecon californica* (Stosich et al. 2022). Historical survey efforts by the BLM in 1993 documented 99 populations across the rangewide distribution, with 91 of these occurring in Clark County, Nevada, and 8 in Mohave County, Arizona (Stosich et al. 2022). The substantial reduction in known occurrences over the intervening decades reflects both the permanent loss of populations to habitat conversion in the Las Vegas Valley and the consolidation of geographically proximate populations into composite occurrence records during more recent inventories.

Habitat Characteristics

Las Vegas bearpoppy is typically found in gypsum-tolerant herbaceous plant communities embedded within creosote bush, saltbush, and occasionally blackbrush scrub ecosystems. Cryptogamic crusts of lichen, moss, and cyanobacteria frequently co-occur with the species and are characteristic of stable gypsum surfaces of intermediate gypsum content (Meyer 1986). Common associated plant species in Clark County occurrences include white bursage (*Ambrosia dumosa*), sticky ringstem (*Anulocaulis leiosolenus*), silverleaf sunray (*Enceliopsis argophylla*), Torrey ephedra (*Ephedra torreyana*), sulphur buckwheat (*Eriogonum insigne*), creosote bush, Parry sandpaper plant (*Petalonyx parryi*), Fremont indigo

bush (*Psorothamnus fremontii*), and catclaw acacia (*Senegalia greggii*) (Ironwood Consulting 2020, 2021).

Although Las Vegas bearpoppy was historically considered a strict gypsum-obligate species, more recent soil surveys and foliar analyses indicate that it is better classified as a gypsovag, a species that can occur on soils with or without gypsum (Stosich et al. 2022). A compilation of 2,575 occurrence records reported that approximately 65 percent of occurrences fall on gypsic soils, while the remaining 35 percent occur on calcid soils derived from limestone parent material with shallow calcium carbonate layers and accumulated carbonate (Childers 2004; Stosich et al. 2022). Foliar calcium and sulfur concentrations in Las Vegas bearpoppy fall within moderate ranges compared with known specialist gypsophiles, suggesting that the species avoids accumulation of these elements rather than requiring elevated tissue concentrations (Stosich et al. 2022). Fine-scale soil mapping at the northern edge of the Las Vegas Valley has shown that the species occurs preferentially on map units typical of spring deposits and basin floor sediments lacking a thick veneer of coarse alluvium, while deep, gravelly soils on alluvial fans do not support the species (Stosich et al. 2022).

Petrocalcic horizons (carbonate-cemented subsurface layers) and petrogypsic horizons (gypsum-cemented subsurface layers) are commonly associated with occupied habitat and appear to play a functional role in supporting the species by limiting downward water movement during winter and spring precipitation events, thereby storing moisture within the rooting zone (Stosich et al. 2022). Petrocalcic horizons have been observed at approximately 30 cm depth at one Las Vegas bearpoppy population, with taproots embedded in the petrocalcic layer (Winkel 2004). The single fragile taproot of the species can reach the top of this petrocalcic layer, with some roots penetrating through it under wet conditions; observed taproot lengths range from approximately 26 cm in plants with 31 rosettes to more than 33 cm in plants with only two rosettes, indicating that taproot depth cannot be predicted from above-ground plant size (Winkel 2004).

Research by Meyer (1986) demonstrated that the unusual vegetation of eastern Mojave Desert gypsum outcrops, including Las Vegas bearpoppy, is primarily a response to the physical rather than the chemical properties of gypsum soils. Gypsum soils in the Las Vegas area have low bulk densities due to the presence of sponge gypsum, and typically present either indurated surface crusts formed by recrystallization of gypsum or well-developed cryptogamic crusts composed mostly of lichens. These surface properties appear to limit seedling establishment of common shrub species such as creosote bush, reducing competition and creating an environment in which gypsum-endemic species can establish. The insulating properties of sponge gypsum may also reduce summer drought stress by moderating near-surface soil temperatures and supporting vapor-phase water movement, an advantage that is reflected in the summer-active phenology shared by most eastern Mojave gypsum endemics (Meyer 1986).

Habitat Suitability Model

Habitat suitability for Las Vegas bearpoppy in Clark County was modeled by Nussear et al. (2024) using an ensemble modeling approach that combined generalized additive models, gradient boosted machines, MaxEnt, and random forests. The ensemble model for Las Vegas bearpoppy performed extremely well across all three standard evaluation metrics: the testing area under the receiver operating characteristic curve was 0.99, the testing continuous BI was 0.96, and the testing TSS was 0.94 (Nussear et al. 2024). The final ensemble integrated 19 random forest models, 10 gradient boosted machine models, 6 generalized additive models, and 5 MaxEnt models (Nussear et al. 2024). An alternative model

that included a vegetation association layer produced nearly identical performance metrics and predicted habitat distribution, indicating that the environmental covariate suite alone adequately captured habitat suitability for this species (Nussear et al. 2024).

Five environmental covariates were used to train the ensemble model: average spring maximum temperature, soil gypsum content, Normalized Difference Vegetation Index amplitude, percent silt in the soil, and the coefficient of variation of winter precipitation (Nussear et al. 2024). Each of the selected variables had high contribution in at least one component model, and variable importance varied substantially among modeling algorithms. Soil gypsum content was the single strongest contributor to the gradient boosted machine and random forest models, with relative importance of 56.3 and 28.9, respectively (Nussear et al. 2024). Average spring maximum temperature was also a dominant contributor across the component models, particularly in the gradient boosted machine and random forest models. The MaxEnt model was most strongly influenced by the coefficient of variation of winter precipitation, while the generalized additive model relied more evenly on silt content, winter precipitation variability, average spring maximum temperature, and NDVI amplitude (Nussear et al. 2024). Relative frequency of vegetation associations at Las Vegas bearpoppy locality points showed that occurrences were largely located within North American Warm Desert Scrub and Grassland, with lower presence in Western North American Cool Semi-Desert Scrub and Grassland and in lands classified as developed (Nussear et al. 2024).

High-suitability habitat for Las Vegas bearpoppy is predicted to occur on exposed gypsum substrates across the Las Vegas Valley and the northeastern portion of Clark County, with the largest concentrations within and adjacent to Lake Mead National Recreation Area, Rainbow Gardens, St. Thomas Point, the Bitter Spring and Echo Junction areas, Gold Butte, and Valley of Fire State Park. The distribution of predicted suitable habitat is shown in Figure 21.

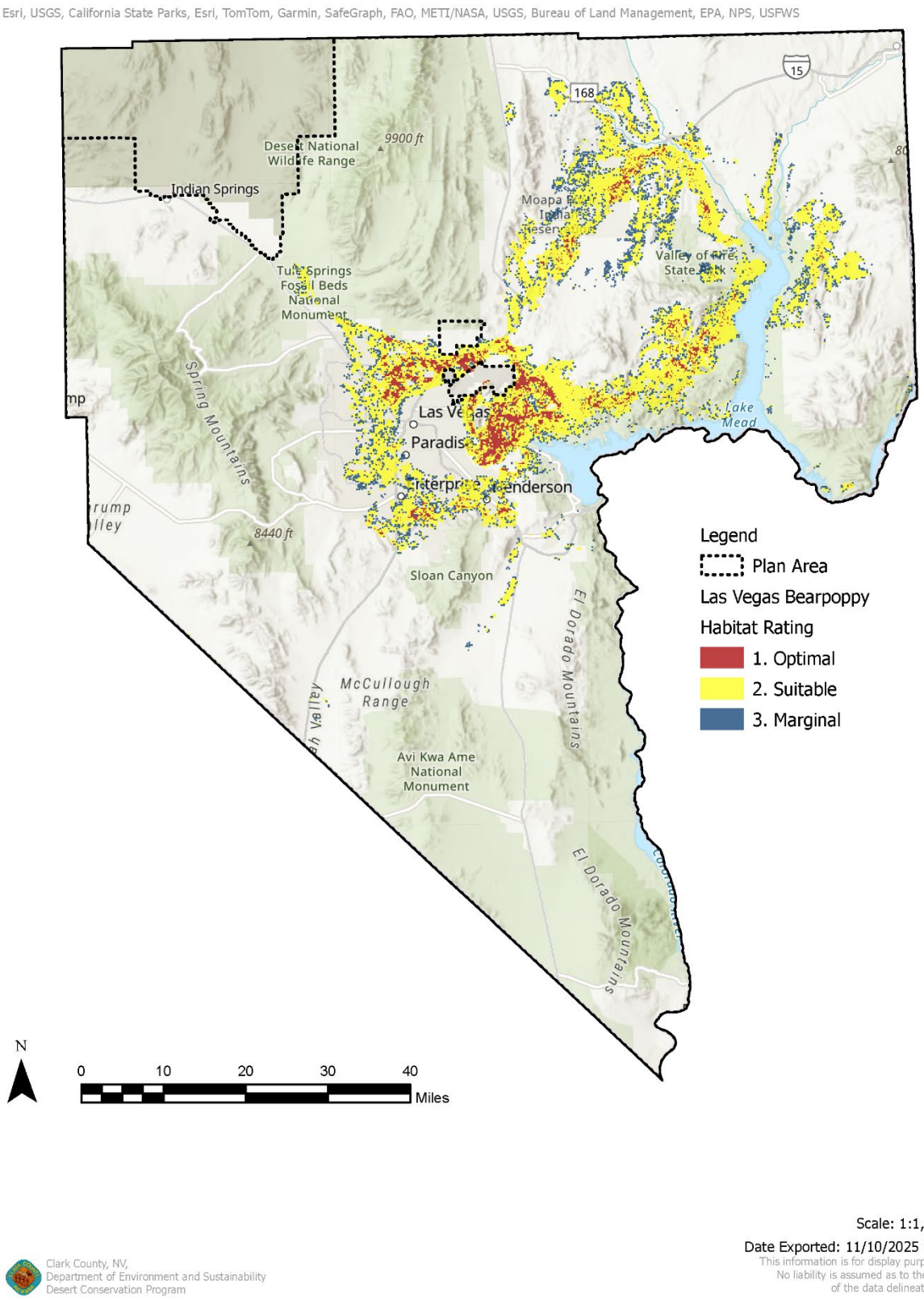

Figure 21. Habitat suitability model for Las Vegas bearpoppy (*Arctomecon californica*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Covered
U.S. Fish and Wildlife Service Endangered Species Act	None*
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	Fully Protected
State of Arizona	Salvage Restricted
NV Division of Natural Heritage	At Risk
NV Climate Change Vulnerability Index	Not Addressed
NatureServe Global and NV State Rank	G1G2 S3
IUCN Red List	None
CITES	None

*In October 2024, the USFWS issued a 12-month finding that listing Las Vegas bearpoppy as an endangered or threatened species was not warranted at that time (USFWS 2024).

Las Vegas bearpoppy is ranked G1G2 (Critically Imperiled to Imperiled) globally by NatureServe, reflecting its restricted range and documented population declines (NatureServe 2023). The species is ranked S3 (Vulnerable) in Nevada and S1S2 (Critically Imperiled to Imperiled) in Arizona, its only two states of occurrence (NatureServe 2023). The species is designated as At Risk by the Nevada Division of Natural Heritage, as Fully Protected by the State of Nevada, as Salvage Restricted by the State of Arizona, and as Sensitive by the BLM in Nevada. It is covered under the Clark County Multiple Species Habitat Conservation Plan (MSHCP 2000).

Las Vegas bearpoppy is not currently listed under the federal Endangered Species Act. In July 2020, the USFWS published a 90-day finding that a petition to list the species presented substantial information indicating that listing may be warranted, and initiated a status review (USFWS 2020; Cornelisse et al. 2019). On October 1, 2024, the Service published a 12-month finding that listing Las Vegas bearpoppy as an endangered or threatened species was not warranted at that time (USFWS 2024). The species has no IUCN Red List designation and is not listed under CITES.

Population Trends

Long-term and short-term population trends for Las Vegas bearpoppy are both estimated by NatureServe to reflect declines of 50 to 90 percent (NatureServe 2023). In 1993, the BLM estimated approximately 830,000 plants across 39,500 acres and 99 populations rangewide, a figure that may reflect a cycle peak following above-average rainfall in 1992 and 1993 (Stosich et al. 2022). By 2000, the occupied range had declined by approximately half, to between 20,000 and 24,000 acres (Stosich et al. 2022). By 2007, estimated totals from 11 previously surveyed sites had fallen to approximately 10,000 plants (Cornelisse et al. 2019; Stosich et al. 2022). The current total population size is unknown but is estimated to fall between 2,500 and 100,000 individuals (NatureServe 2023). As of 2023, approximately 57 occurrences were known rangewide, a reduction from 108 occurrences documented in Nevada as of 1997 (NatureServe 2023). Only about six occurrences are considered to have good or excellent viability (NatureServe 2023).

Population fluctuations are driven in part by weather cycles and reliance on the persistent soil seed bank. Many fragmented populations in the Las Vegas Valley were declared extirpated during 1996 and 1998 surveys, yet plants were detected at several of these sites following above-average winter rainfall in 2004 and 2005, reflecting the emergence of seedlings from long-dormant seed reserves (Stosich et al. 2022). Eastern populations on protected lands, particularly within Lake Mead National Recreation Area and Gold Butte National Monument, are considered relatively stable when accounting for precipitation-driven recruitment pulses, whereas western Las Vegas Valley populations have experienced greater fragmentation and loss (Stosich et al. 2022).

Habitat Level Threats

The restriction of Las Vegas bearpoppy to small and patchy soil resources makes the species particularly vulnerable to habitat-level threats. Principal habitat-level threats in Clark County include residential development and urbanization, gypsum mining, and fragmentation of gypsum outcrops by roads, utility corridors, and other infrastructure (Cornelisse et al. 2019; NatureServe 2023). Substantial areas of historical habitat within the Las Vegas Valley have been permanently lost to urban expansion and mining operations (Stosich et al. 2022).

Off-highway vehicle use, unauthorized travel routes, and other forms of motorized and non-motorized recreation represent significant habitat-level threats, particularly because the soft, friable surface crusts of gypsum soils are easily damaged and slow to recover (Cornelisse et al. 2019; NatureServe 2023). Damage to the cryptogamic crusts that characterize stable soil surfaces may alter seedling establishment conditions for both Las Vegas bearpoppy and co-occurring species (Meyer 1986). Livestock grazing, particularly by wild burros, has also been identified as a habitat-level threat at multiple occurrences (Ironwood Consulting 2020, 2021). Trespass cattle have also been documented in occupied habitat within Lake Mead National Recreation Area, with sightings increasing in the northern portion of the recreation area following sustained declines in Lake Mead water levels; in 2009, cattle were observed within one kilometer of rare plant habitat near Northshore Road and Overton Beach Road, and preliminary surveys were conducted to estimate the extent of cattle trails in the area (Bangle et al. 2010).

Extreme or prolonged drought, consistent with projected climate change in the Mojave Desert, is expected to reduce the frequency of the above-average winter precipitation events that drive successful germination and recruitment from the soil seed bank (Stosich et al. 2022). Because seed bank germination is strongly dependent on November through March precipitation and on periods of cold for dormancy break, climate change is expected to decouple the environmental cues that historically have permitted episodic recruitment (Stosich et al. 2022). Although invasive species are generally less prevalent on harsh soils than on adjacent alluvial soils, the recent spread of African mustard (*Malcolmia africana* [also treated as *Strigosella africana*]) has been identified as a potential threat to plant communities in Clark County (Bangle et al. 2010).

Threats to Species

Direct threats to Las Vegas bearpoppy in Clark County include the decline of its specialist pollinator, reduced seed set in small and fragmented populations, trampling and mechanical damage from recreation and grazing, and demographic and genetic stochasticity associated with small, isolated populations (Cornelisse et al. 2019; NatureServe 2023; Stosich et al. 2022). Because the species is dependent on the Mojave poppy bee (*Perdita meconis*) for effective pollination and seed production,

declines in the pollinator represent a direct demographic threat. Recent surveys have documented that more than one-third of surveyed Las Vegas bearpoppy populations declined severely between 2020 and 2023, with no Mojave poppy bee detections at those sites (U.S. Department of Agriculture 2024). Populations west of the Virgin River arm of Lake Mead have been disproportionately affected by host plant declines, while the most robust Las Vegas bearpoppy populations are concentrated in the eastern portion of the county within Gold Butte National Monument (U.S. Department of Agriculture 2024).

Seed bank studies in Las Vegas bearpoppy habitat have shown that the species is detectable in soil seed samples only through seed extraction methods and not through standard greenhouse emergence methods, suggesting complex dormancy requirements that are not easily met in cultivation (Abella et al. 2013). This finding has implications for the species' reintroduction potential, indicating that direct seeding or establishment from soil seed bank transplants may be less effective than has been assumed and highlighting the importance of protecting existing occupied habitat with intact seed reserves (Abella et al. 2013; Stosich et al. 2022).

Las Vegas bearpoppy is largely self-incompatible, requiring pollen transfer between different individuals to achieve successful fertilization (Stosich et al. 2022). Fragmented populations in the western Las Vegas Valley have exhibited measurable reductions in genetic variation and lower seed set, with plants at fragmented sites producing two to three times fewer seeds compared with plants in unfragmented habitat within Lake Mead National Recreation Area (Hickerson and Wolf 1998; Stosich et al. 2022). Greater distance between flowering plants reduces pollinator visitation rates, and maximum fertilization requires multiple pollinator visits during the two-day period when stigmas are receptive (Stosich et al. 2022). Population viability analysis has indicated that small, fragmented populations in the Las Vegas Valley experience low seed set due to pollinator limitations and may persist largely on their long-developed seed reserves; these populations could become extirpated if the seed reserves become depleted without periodic inputs during years with successful seed set (Stosich et al. 2022).

The Mojave poppy bee (*Perdita meconis*) is a solitary ground-nesting bee that specializes on *Arctomecon* and *Argemone* species and has been petitioned for listing under the Endangered Species Act (Stosich et al. 2022). Because most solitary bees require nesting and host-plant sites to occur within 100 m of each other, and because *P. meconis* is a small specialist bee with a correspondingly short foraging range, fragmentation of Las Vegas bearpoppy habitat that isolates flowering plants from suitable nesting substrate represents a distinct threat beyond the loss of host plants themselves (Stosich et al. 2022). The pollinator specializes on open patches of gypsum soil for nesting, a resource that is particularly vulnerable to surface disturbance from off-highway vehicle use, development, and trampling (Stosich et al. 2022). Other effective pollinators of Las Vegas bearpoppy include *Megandrena enceliae* and the European honey bee (*Apis mellifera*); however, European honey bees visit flowers at sites with 45 or more plants in bloom and typically gather pollen from only a few flowers per visit, making them less effective cross-pollinators (Stosich et al. 2022).

Reproductive failure in Las Vegas bearpoppy occurs primarily through tissue abortion of buds and capsules rather than insect herbivory, with high attrition occurring when late-season buds abort at the onset of spring environmental stress (Thompson and Smith 1997; Stosich et al. 2022). This reproductive sensitivity is expected to be exacerbated under projected climate change scenarios that include more variable precipitation and a potential shift to more spring-dominant rainfall, potentially disrupting synchrony between Las Vegas bearpoppy flowering and pollinator emergence (Stosich et al. 2022). The invasion of Africanized honey bees into the region in 1998 had relatively little impact on *Perdita*

populations in southern Nevada, in contrast to the situation in southern Utah, where Africanized honey bee invasion in 2000 coincided with local extirpation of *P. meconis* from dwarf bearpoppy (*A. humilis*) habitat (Stosich et al. 2022). The higher floral diversity of Las Vegas bearpoppy habitat in Clark County, partially attributable to Mojave desert tortoise conservation efforts that have retired grazing allotments on BLM and NPS lands, provides alternative forage that appears to buffer specialist pollinator populations from Africanized honey bee competition (Stosich et al. 2022).

Conservation and Management

The Las Vegas bearpoppy occurs on multiple protected or conservation-managed land units, including Tule Springs Fossil Beds National Monument, Lake Mead National Recreation Area, and Grand Canyon National Park (NPS); Nellis Air Force Base (Department of Defense); Valley of Fire State Park (State of Nevada); and lands managed by the BLM, including reserve areas designated under the MSHCP (NatureServe 2023; RECON 2000).

The Nature Conservancy (2007) developed a conservation management strategy for nine low-elevation rare plants in Clark County, including Las Vegas bearpoppy, which identifies habitat protection, monitoring, and research priorities for the species. Administrative and legislative efforts have also been undertaken to protect reserve areas on BLM lands as ACECs (NatureServe 2023). Stosich et al. (2022) provide a recent synthesis of conservation needs, including recommendations for improved propagation and reintroduction protocols, expanded pollinator conservation to support the Mojave poppy bee, and sustained long-term monitoring to detect recruitment pulses following favorable precipitation years.

Propagation and reintroduction research has been pursued to support Las Vegas bearpoppy conservation, although this work has faced substantial technical challenges. Seed germination requires an extended period of cold stratification to overcome the intermediate complex morphophysiological dormancy characteristic of the species, and germination rates in controlled trials have ranged from approximately 5 percent during initial stratification periods to nearly 19 percent after additional cold stratification cycles (Pereira et al. 2021; Stosich et al. 2022). Seeds stratified in the field have exhibited much lower germination, indicating that year-to-year temperature variability and soil moisture conditions in Las Vegas bearpoppy habitat may not consistently meet the stratification requirements for natural recruitment (Pereira et al. 2021). Direct seeding trials at Rainbow Gardens and Gold Butte have achieved some seedling establishment, and ongoing restoration research is evaluating the role of biocrust treatments in promoting seedling recruitment (Stosich et al. 2022).

Salvage and transplantation efforts conducted in the late 1990s and early 2000s by the Las Vegas Valley Water District and Southern Nevada Water Authority had limited long-term success, with rapid mortality of most transplanted adult plants and higher short-term survival of seedlings salvaged with 30 cm soil columns during December dormancy (Stosich et al. 2022). A soil salvage effort at Rainbow Gardens during construction of a transmission line in late 2018, in which topsoil was removed and replaced following project completion, produced approximately 80 seedlings across about 150 linear feet of replaced topsoil after winter 2019 to 2020 precipitation, though most of these had died by late 2020 following below-average rainfall (Stosich et al. 2022). These outcomes indicate that topsoil salvage can preserve some seed bank function but that post-replacement survival is highly dependent on subsequent precipitation conditions.

Site-specific conservation actions for Las Vegas bearpoppy in Clark County include a conservation set-aside of more than 230 acres of bearpoppy habitat on Nellis Air Force Base, established in 2007 under a

permit granted by the Nevada Division of Forestry in cooperation with the USFWS and the Nevada Natural Heritage Program, as well as an approximately 300-acre conservation easement near the North Las Vegas Airport. Priority research directions identified in recent syntheses include characterizing the viable fraction of the soil seed bank through combined extraction and emergence methods, developing germplasm collections to preserve genetic diversity against the risk of population extirpation, and investigating the potential role of cryptogamic crusts and arbuscular mycorrhizal fungi in supporting seedling establishment (Stosich et al. 2022).

Nussear et al. (2024) modeled Las Vegas bearpoppy habitat suitability. Approximately 492,466 acres of modeled medium- and high-suitability habitat exist within the MSHCP Amendment Plan Area. It is estimated that approximately 8.4 percent (41,479 acres) of suitable habitat may be impacted by covered activities, and 33.3 percent (163,990 acres) occur on lands managed for resource conservation. Approximately 0.1 percent (564 acres) of suitable habitat is protected within the existing MSHCP Reserve System, and an additional 11.6 percent (56,997 acres) is within the MSHCP Amendment Reserve System Additions (Nussear et al. 2024).

Las Vegas bearpoppy (*Arctomecon californica*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	492,466	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	41,479	8.4%
Suitable Habitat in Lands Managed for Resource Conservation	163,990	33.3%
Suitable Habitat in the existing MSHCP Reserve System	564	0.1%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	56,997	11.6%

**Source: Nussear et al. 2024.*

Clark County Survey Data

Systematic inventory and monitoring of Las Vegas bearpoppy in Clark County has been conducted over several decades through a combination of agency, academic, and contractor-led efforts. The BLM and the NPS at Lake Mead National Recreation Area have maintained long-standing programs focused on conservation of the species, including the collection of occurrence, density, and habitat-condition data (The Nature Conservancy 2007). Early rangewide population estimates by the BLM (1993) documented approximately 830,000 plants across 39,500 acres, although this figure has since been recognized as likely reflecting a cycle peak following above-average rainfall (Stosich et al. 2022).

Between 2004 and 2007, the University of Nevada, Las Vegas, conducted revisits of Las Vegas Valley populations that had previously been declared extirpated during surveys in 1996 and 1998, detecting plants at 5 of 10 such sites following above-average winter precipitation in 2004 and 2005 (The Nature Conservancy 2007; Stosich et al. 2022). These revisit surveys confirmed the importance of the persistent soil seed bank and the role of episodic recruitment events in maintaining Las Vegas bearpoppy populations.

Between 2007 and 2009, the NPS at Lake Mead National Recreation Area, in cooperation with the BLM and the University of Nevada, Las Vegas, implemented a long-term monitoring program for Las Vegas bearpoppy, with monitoring objectives focused on detecting changes of 30 percent or greater in bearpoppy density, associated abiotic factors, and native plant community biodiversity over a 10-year horizon (Bangle et al. 2010). Sampled sub-populations included Blue Point, Road 100, Sunrise Hills, Valley

of Fire, Gold Butte, and Gale Hills, and a new sub-population of approximately 3,000 individuals was documented in the Gale Hills area during 2008 inventories (Bangle et al. 2010). Plant counts declined between 2008 and 2009 at all sites except Sunrise Hills, with total plants across sub-populations decreasing from 584 in 2008 to 480 in 2009; these declines were interpreted as consistent with the normal attrition of older cohorts in the absence of a recruitment event, as very few seedlings were observed in either year and neither year received the above-average cold winter precipitation thought to trigger large recruitment pulses (Bangle et al. 2010).

Between April 2009 and May 2010, ICF Jones & Stokes conducted surveys for ten rare plant species, including Las Vegas bearpoppy, at 511 randomly selected four-hectare survey plots distributed across thirteen Geographic Units in Clark County (ICF Jones & Stokes 2010). Survey plot locations were selected using a predictive ecological model developed by the Desert Conservation Program and were screened for accessibility and appropriateness, with field teams systematically surveying each plot on foot using transects spaced approximately 30 feet apart or following topography where this spacing was not feasible (ICF Jones & Stokes 2010). Target plant observations were recorded both within survey plots and incidentally while traveling to or from plots. Las Vegas bearpoppy was the most commonly observed target species across the project, with 31 total observations comprising 17 observations within survey plots and 14 incidental observations made while traveling to or from plots (ICF Jones & Stokes 2010). Evidence of trails or off-highway vehicle use was recorded more frequently at Las Vegas bearpoppy locations than at most other target species locations during the project; the authors hypothesized that the open, largely unvegetated, soft-soiled habitats preferred by Las Vegas bearpoppy may be more easily navigated by off-highway vehicles than habitats of other target species (ICF Jones & Stokes 2010).

More recent targeted rare plant surveys for the Clark County Desert Conservation Program, conducted by Ironwood Consulting, have provided detailed occurrence data across multiple years. In 2020, Las Vegas bearpoppy was documented at four locations within St. Thomas Point, encompassing approximately 34 acres of occupied area and 690 individuals across an elevation range of 415 to 462 m (1,362 to 1,516 ft). Occurrence quality was rated good to excellent. Common associated species included white bursage (*Ambrosia dumosa*), sulphur buckwheat (*Eriogonum insigne*), creosote bush (*Larrea tridentata*), and catclaw acacia (*Senegalia greggii*) (Ironwood Consulting 2020).

In 2021, Ironwood Consulting surveys documented Las Vegas bearpoppy at two locations within Echo Junction, three locations at Bitter Spring, and one location within Gold Butte West, encompassing a total of approximately 22.9 acres of occupied area and 579 individuals across an elevation range of 464 to 621 m (1,522 to 2,037 ft). Occurrence quality ranged from good to excellent, with some mortality attributed to multiple seasons of drought. Common associated species included sticky ringstem (*Anulocaulis leiosolenus* var. *leiosolenus*), silverleaf sunray (*Enceliopsis argophylla*), Torrey ephedra (*Ephedra torreyana*), and Fremont indigo bush (*Psorothamnus fremontii*). The proximity of several occurrences to other documented *A. californica* occurrences suggests that gene flow may be occurring between adjacent subpopulations (Ironwood Consulting 2021).

Surveys conducted in 2023 documented Las Vegas bearpoppy at two locations, Bitter Spring North and Echo Hills North, both of which represented new or expanded occurrence records. The total occupied area across both occurrences was approximately 0.1 acre (0.04 ha) and seven individuals, across a mean elevation range of 550 to 574 m (1,804 to 1,883 ft). Occurrence quality was rated as fair at both locations due to dry conditions and evidence of off-highway vehicle tracks running nearby and outside designated routes (Ironwood Consulting 2023).

Pollinator-focused surveys conducted from 2020 through 2023 have provided additional information on the condition of Las Vegas bearpoppy populations in Clark County. More than one-third of surveyed Las Vegas bearpoppy populations declined severely between 2020 and 2023, with no detections of the specialist Mojave poppy bee at those sites. For example, the Rainbow Gardens North occurrence supported a healthy Mojave poppy bee population in 2020 but had declined to only two flowering plants by 2023, with no bee detections. Sites west of the Virgin River arm of Lake Mead were disproportionately affected by host plant declines, while the most robust Las Vegas bearpoppy populations, and corresponding Mojave poppy bee detections, were concentrated in the eastern portion of the county within Gold Butte National Monument (U.S. Department of Agriculture 2024).

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Threecorner Milkvetch (*Astragalus geyeri* var. *triquetrus*)

Photo Credit: Stefanie Ferrazzano, Clark County

Photo Credit: Ironwood Consulting

Species Overview

Threecorner milkvetch (*Astragalus geyeri* var. *triquetrus*) is a tiny, prostrate, sand-loving (psammophylic) winter annual in the pea family (Fabaceae) that is endemic to the eastern Mojave Desert (Swearingen 1981, Bangle 2012, NatureServe 2026). Threecorner milkvetch is taxonomically a variety of *Astragalus geyeri*, with the synonym *Astragalus triquetrus* also appearing in some literature (NatureServe 2026). The species was originally described as occupying consolidated sand dunes (Niles et al. 1995), although more recent observations document its occurrence on unconsolidated dunes as well (Powell 1999). Plants are of short stature and bloom only briefly, typically flowering from February through April and making them one of the first species to bloom in early spring (Swearingen 1981, Bangle 2012, DeFalco et al. 2023).

Threecorner milkvetch has a life history adapted to the variable and unpredictable rainfall regime of the eastern Mojave Desert. As with other desert winter annuals, seed dormancy creates a persistent soil seed bank that buffers populations against years when environmental conditions would otherwise cause catastrophic mortality (DeFalco et al. 2023). Germination is heavily influenced by autumn and winter precipitation, and the species does not bloom every year; in drought years, plants may be entirely absent from habitat and persist only as seeds in the seed bank (Hiatt and Boone 2003, DeFalco et al. 2023, NatureServe 2026). Because this species inhabits unconsolidated dunes, shifting dune surfaces may intermittently bury or expose propagules in the seed bank, potentially increasing the variability in abundance measured during annual surveys and confounding population trend estimates (Powell 1999).

Population abundance of threecorner milkvetch is highly variable from year to year and is strongly dependent on annual precipitation and on winter and spring temperatures (Powell 1999, Bangle 2012, NatureServe 2026). The combination of short stature, brief bloom time, and episodic germination makes detection difficult even in occupied habitat (NatureServe 2026). Recent efforts to propagate the species *ex situ* from seed bank soil samples collected from four population groups during the 2020 to 2022 megadrought yielded no seedlings during a nine-month greenhouse incubation, and no seeds of the species were recovered from soil samples sieved at the end of the incubation period, suggesting that seeds of threecorner milkvetch were extremely rare or absent from the seed bank in those locations during the drought period (DeFalco et al. 2023). Ecosystems associated with higher suitability habitat include Mojave desert scrub, particularly within North American Warm Desert Scrub and Grassland vegetation associations (SWECO 2018, Nussear et al. 2024).

Range

Threecorner milkvetch has a restricted range that occurs almost entirely within Clark County, Nevada, with limited occurrences in Lincoln County, Nevada and Mohave County, Arizona (Swearingen 1981, Bangle 2012, USFWS 2021b, NatureServe 2026). NatureServe estimates the range extent at 1,000 to 5,000 square kilometers (approximately 400 to 2,000 square miles), based on herbarium specimens, photo-based observations, and NatureServe Network occurrence data collected between 1993 and 2024 (NatureServe 2026).

Within Nevada, the species occurs on sandy soils derived from the Tertiary-aged Muddy Creek Formation and redistributed as Aeolian and fluvial deposits along the Muddy and Virgin rivers and the Overton Arm of Lake Mead from Sandy Cove and Middlepoint to the Mormon Mesa (Niles et al. 1995, NNHP 2001, Bangle 2012). The range extends from Dry Lake Valley in the west to the confluence of the Muddy and Virgin rivers in the east, and from Sandy Cove and Ebony Cove on the north shore of Boulder Basin at Lake Mead in the south to the Virgin River drainage in the far northeast of the county, including populations near the Muddy River drainage (Niles et al. 1995, TNC 2007, Bangle 2012). The Nature Conservancy (2007) recognized 17 population groups for the species, including Mud Lake, California Wash, Weiser Wash, Logandale, Muddy River, Toquop Wash, Ebony Cove, Valley of Fire Wash, Sandy Cove, Bark Bay, and Mormon Mesa, among others (TNC 2007, DeFalco et al. 2023). A single population occurs in northwestern Arizona in Mohave County, while the remainder of known occurrences are in Clark County (NatureServe 2026).

Habitat Characteristics

Threecorner milkvetch grows on sand or sandy soil, including on flats, dunes, washes, and gullies, at elevations from 350 to 850 meters (approximately 1,150 to 2,790 feet) (NatureServe 2026). Terrestrial habitats in which the species occurs include sand dunes and bare rock, talus, or scree (NatureServe 2026). The species is strongly associated with Aeolian sand deposits derived from the Muddy Creek Formation along the Muddy and Virgin River drainages and the Overton Arm of Lake Mead (NNHP 2001, Bangle 2012). Habitat is frequently situated within Mojave desert scrub plant communities, and the species has been documented in association with gravel milkvetch (*Astragalus sabulonum*), big galleta (*Hilaria rigida*), large desert evening primrose (*Oenothera deltoides*), and apricot mallow (*Sphaeralcea ambigua*) (Ironwood Consulting 2023). As a winter annual, threecorner milkvetch depends on autumn and winter rainfall to trigger germination and support seedling growth to reproduction, such that seeds can replenish the soil seed bank (DeFalco et al. 2023).

Habitat Suitability Model

Nussear et al. (2024) developed an ensemble habitat suitability model for threecorner milkvetch using six environmental covariates: winter precipitation, winter minimum temperature, Normalized Difference Vegetation Index amplitude, slope, silica index, and sandy soils. A parallel model that also incorporated a vegetation layer was produced. Model performance was mixed across algorithms, with very high Area Under the Curve, BI, and TSS scores for some algorithms, and poorer performance for others such as GAMs (GAMs). The threecorner milkvetch ensemble model was comprised of 14 RF, 11 MaxEnt, 14 GBM, and 1 GAM model; the model including the vegetation layer was composed of 14 RF and 10 GBM models (Nussear et al. 2024).

The most influential variable across algorithms was the silica index, which was the dominant predictor in the MaxEnt model (approximately 99.7 percent importance) and in the GBM model (approximately 89.4

percent importance). Winter precipitation, winter minimum temperature, NDVI amplitude, slope, and sandy soils each contributed more than 10 percent relative importance in at least one algorithm. In the model including the vegetation layer, the vegetation covariate contributed approximately 4 percent importance in the RF model (Nussear et al. 2024).

Predicted high-suitability habitat is concentrated in the northeastern extent of Clark County, particularly in the Virgin and Muddy River area, Mormon Mesa, and Moapa. Medium- and high-suitability habitat are also predicted to occur north of Lake Mead and in the Ivanpah Valley. Habitat projections with and without the vegetation layer were very similar (Nussear et al. 2024). Vegetation associated with threecorner milkvetch locality points was largely within North American Warm Desert Scrub and Grassland. The habitat suitability model for threecorner milkvetch is shown in Figure 22.

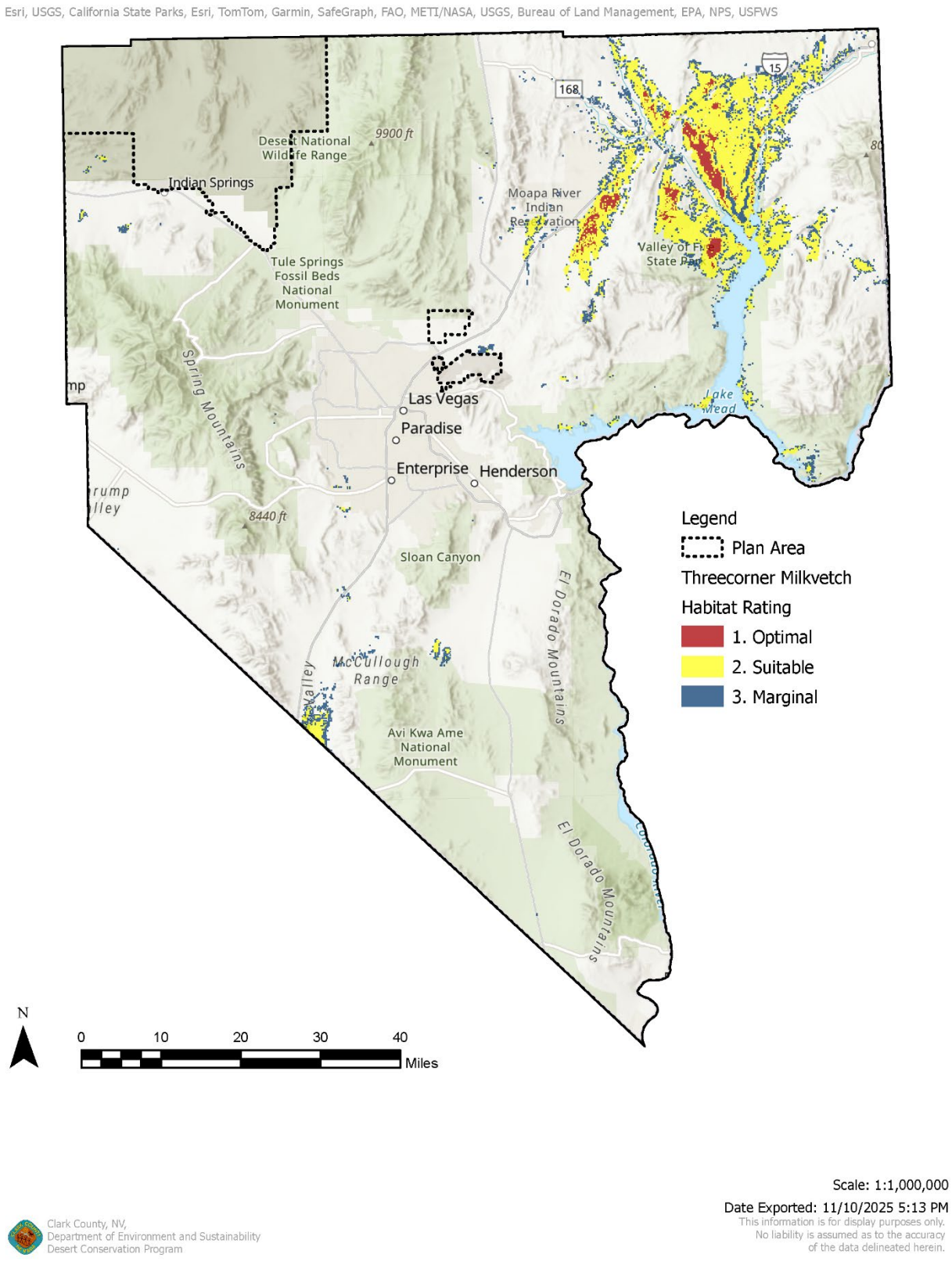

Figure 22. Habitat suitability model for threecorner milkvetch (*Astragalus geyeri* var. *triquetrus*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Covered
U.S. Fish and Wildlife Service Endangered Species Act	Under Review*
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	Fully Protected (Critically Endangered)
State of Arizona	Special-status species
NV Division of Natural Heritage	At Risk
NV Climate Change Vulnerability Index	Not Addressed
NatureServe Global and NV State Rank	G4T2 S2S3
IUCN Red List	None
CITES	None

* Former USFWS Category 2 Candidate, defined as taxa for which information in the possession of the Service indicated that proposing to list as endangered or threatened was possibly appropriate, but for which persuasive data on biological vulnerability and threat were not currently available to support proposed rules (USFWS 1993). The USFWS has revised its policy on Candidate Species and no longer includes this category. The species is currently under an active status review (USFWS 2021a, USFWS 2021b, USFWS 2024, NatureServe 2026).

Threecorner milkvetch is currently under review for federal protection under the Endangered Species Act. On April 25, 2019, Basin and Range Watch and Western Watersheds Project petitioned for the species to be emergency listed as threatened or endangered and for critical habitat to be designated. Because the Act does not provide for emergency listing petitions, USFWS evaluated the petition under the standard 90-day process (USFWS 2021b). On March 24, 2021, USFWS published a positive 90-day finding, determining that the petition presented substantial scientific or commercial information indicating that listing may be warranted, and announcing initiation of a status review (Federal Register Vol. 86, No. 55; USFWS 2021a). The finding identified credible and substantial information of threats to the species from energy development, utility transmission infrastructure, and weedy invasive plants under Factor A of the Act, as well as from the inadequacy of existing regulatory mechanisms under Factor D (USFWS 2021b). The status review is being conducted by the USFWS Southern Nevada Fish and Wildlife Office under Docket No. FWS-R8-ES-2020-0056.

Threecorner milkvetch has been included in the USFWS FY23 to 27 National Domestic Listing Workplan (April 14, 2023 version) and the FY24 to 28 National Domestic Listing Workplan (May 23, 2024 version), and the Endangered Species Act status remains Under Review as of the date of this report (USFWS 2023, USFWS 2024, NatureServe 2026). The species is listed as critically endangered (Fully Protected) by the State of Nevada and occurs on the BLM Nevada Sensitive Species list (NNHP 2001, USFWS 2021b, NatureServe 2026).

NatureServe assigns threecorner milkvetch a global conservation status of G4T2 (Imperiled Variety), with a national status of N2 in the United States. State ranks are S1 (Critically Imperiled) in Arizona and S2S3 (Imperiled to Vulnerable) in Nevada. The global status was most recently reviewed on April 15, 2024. The degree of threat is assessed as High. The species is not currently listed on the IUCN Red List and is not included in CITES appendices (NatureServe 2026).

Population Trends

Population trends for threecorner milkvetch are difficult to estimate because the species is a winter annual whose germination is heavily influenced by annual precipitation, producing large interannual variation in abundance (Hiatt and Boone 2003, NatureServe 2026, DeFalco et al. 2023). The species does not bloom every year, and plants are easily missed due to short bloom time and small stature (NatureServe 2026).

NatureServe estimates a long-term trend of decline of 10 to 50 percent, and a short-term trend that is relatively stable (less than or equal to 10 percent change). No specific long-term trend data are available, but some decline is considered almost certain given past and present intensive development in southern Nevada. Inappropriate livestock grazing and trampling, non-native plants, and off-road vehicle use are known to have impacted habitat, and occupied habitat was likely lost to the filling of Lake Mead (RECON 2000, NatureServe 2026). Global abundance is considered unknown and is highly variable due to precipitation dependence; the species is easily missed due to its short bloom time and small stature (NatureServe 2026).

Recent survey effort documents the severity of population fluctuations. Clark County Desert Conservation Program surveys by Ironwood Consulting recorded approximately 250 plants across 14 sites in 2020, zero plants in 2021 and 2022, and 14 plants at two sites in 2023 (Ironwood Consulting 2020, Ironwood Consulting 2021, Ironwood Consulting 2023). Parallel USGS seed ecology work during 2020 to 2022 detected no live *Astragalus geyeri* var. *triquetrus* plants at any of the 17 known population groups during spring field surveys, and no seeds of the species emerged from soil seed bank samples collected from four populations (California Wash, Mud Lake, Bark Bay, Sandy Cove) during a nine-month greenhouse incubation (DeFalco et al. 2023). These findings indicate that during the prolonged megadrought, the species was extremely rare or absent even from the persistent seed bank.

NatureServe estimates approximately 56 occurrences range-wide based on herbarium specimens, photo-based observations, and NatureServe Network occurrence data collected between 1993 and 2024, with a 1-kilometer minimum separation distance applied. The area of occupancy is estimated at 103 grid cells (2 kilometers by 2 kilometers) using the same datasets. Of the eighteen occurrences that have been ranked for viability, six have a rank of Good (B), and none have a rank of Very Good (A) (NatureServe 2026).

Habitat Level Threats

Threecorner milkvetch habitat is threatened by a range of human activities concentrated within the species' narrow Clark County range. NatureServe (2026) assesses the overall degree of threat as High, identifying road construction and maintenance, off-highway vehicle use, solar energy developments, invasive species, and climate change (including increased intensity and length of droughts and increased intensity of storms and flooding) as primary habitat-level threats. Numerous utility-scale solar developments, high-voltage power lines, buried pipelines, highways, and surface roads impact various parts of the species' range (NatureServe 2026).

Energy development has been specifically identified as a credible, substantial threat to the species under Factor A of the Endangered Species Act (USFWS 2021b). The Gemini Solar Project is sited within occupied threecorner milkvetch habitat. Three utility-scale photovoltaic projects approved in 2015 for construction in the Dry Lake Solar Energy Zone (Dry Lake Solar Energy Center, Harry Allen Solar Energy Center, and Playa Solar Project) are located adjacent to the Mud Lake population, and the Environmental

Assessments for these projects identified potential negative effects to threecorner milkvetch habitat, including habitat modification through the introduction of invasive species (BLM 2014a, BLM 2014b, BLM 2014c, BLM 2019, USFWS 2021b).

Utility transmission, construction, and maintenance activities also pose habitat-level threats. Construction and maintenance within corridors can disturb soils and facilitate the introduction and spread of invasive plant species.

Invasive weedy plant species constitute an additional, pervasive threat to threecorner milkvetch habitat. Sahara mustard (*Brassica tournefortii*), listed as a noxious weed by the Nevada Department of Agriculture, dramatically expanded its range after 2005 and is now recorded throughout Clark County, including within or near nearly all known threecorner milkvetch populations (NPS 2010, NDA 2018, Hiatt 2019 in USFWS 2021b). Negative effects of invasive plant species, including Sahara mustard, red brome (*Bromus rubens*), and Mediterranean grass (*Schismus* sp.), on threecorner milkvetch habitat include dune patch stabilization, soil moisture and fire regime alteration, increased fire hazards, increased competition, and reduced biodiversity (USDI-FWS 2001, NPS 2010, BLM 2019, USFWS 2021b). Powell (1999) identified Sahara mustard and Mediterranean grass as potential habitat threats that can outcompete or stabilize the sandy systems in which threecorner milkvetch occurs. Feral burros are also widespread across the species' range (NatureServe 2026).

Historical and ongoing flooding associated with the operation of Hoover Dam has inundated occupied areas under Lake Mead. Fluctuations in lake levels allow some areas to be recolonized by the species but those areas can subsequently be flooded again (NatureServe 2026).

Threats to Species

Direct threats to threecorner milkvetch individuals and populations, especially within Clark County, include trampling and crushing from off-highway vehicle use around Mesquite, Valley of Fire, and Mormon Mesa, which has impacted occupied habitat (NatureServe 2026). Visitor use of Lake Mead beaches disturbs adjacent populations, and increased recreation and visitor use in park units within the species' range is expected to continue as the Las Vegas metropolitan area grows (USFWS 2021b, NatureServe 2026).

Climate change and ongoing megadrought represent significant threats to species persistence. The southwestern United States is experiencing rapid intensification of an emerging megadrought, bringing decreased and more variable cool-season rainfall and longer and more variable drought events (Williams et al. 2022, Zhang et al. 2021, as cited in DeFalco et al. 2023). Because threecorner milkvetch is a winter annual that depends on adequate autumn and winter rainfall to trigger germination from the persistent seed bank, prolonged drought directly threatens annual recruitment. During the 2020 to 2022 megadrought period, live plants were absent from field surveys across all 17 known population groups, and in the case of the USGS seed bank study, seeds of the species could not even be recovered from habitat soils at four populations (DeFalco et al. 2023). Continued drying and warming under climate change could compromise the ability of the persistent seed bank to buffer populations against catastrophic mortality events.

Other threats noted in the 90-day petition review for potential evaluation during the 12-month status review include livestock grazing, urban development, habitat fragmentation, and blockage or disruption of Aeolian sand-transport corridors (USFWS 2021b).

Conservation and Management

BLM Nevada manages the species as a Sensitive Species, which is intended to promote conservation and to minimize the likelihood and need for listing under the Endangered Species Act (BLM 2008). The State of Nevada affords the species Fully Protected status (NNHP 2001).

Significant portions of the species' range occur on federally managed conservation lands. Eight populations occur within Lake Mead National Recreation Area, and three additional populations occur within Gold Butte National Monument (NatureServe 2026). Although the species is protected as critically endangered by the State of Nevada, no habitat is specifically designated for protection of this species (NatureServe 2026).

Nussear et al. (2024) modeled threecorner milkvetch habitat suitability using winter precipitation, winter minimum temperature, NDVI amplitude, slope, silica index, sandy soils, and vegetation. Approximately 285,042 acres of modeled suitable habitat exist within the MSHCP Amendment Plan Area. It is estimated that approximately 7.2 percent (20,518 acres) of this habitat may be impacted by covered activities. Approximately 34.0 percent (96,853 acres) of suitable habitat occurs within lands managed for resource conservation, and 0.6 percent (1,625 acres) falls within the existing MSHCP Reserve System. An additional 5.6 percent (15,918 acres) of suitable habitat is located within MSHCP Amendment Reserve System additions (Nussear et al. 2024).

Threecorner milkvetch (*Astragalus geyeri* var. *triquetrus*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	285,042	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	20,518	7.2 percent
Suitable Habitat in Lands Managed for Resource Conservation	96,853	34.0 percent
Suitable Habitat in the existing MSHCP Reserve System	1,625	0.6 percent
Suitable Habitat in the MSHCP Amendment Reserve System Additions	15,918	5.6 percent

* Nussear et al. 2024.

Clark County Survey Data

Threecorner milkvetch presents significant challenges for population monitoring due to its ephemeral, precipitation-dependent life history. Survey records in Clark County span multiple decades and document the strong influence of annual precipitation on detectability.

Early survey effort by Niles et al. (1995) documented threecorner milkvetch and co-occurring sticky buckwheat (*Eriogonum viscidulum*) in Lake Mead National Recreation Area and adjacent regions of Nevada and Arizona. Subsequent monitoring work by Bangle (2012) within Lake Mead National Recreation Area, prepared for the Lower Colorado River Multi-Species Conservation Program, provided baseline information on population locations and habitat associations. The Nature Conservancy (2007) summarized information for threecorner milkvetch and eight other low-elevation rare plant species in Clark County, recognizing 17 population groups.

Between 2008 and 2009, the NPS conducted inventory, research, and monitoring for threecorner milkvetch at Lake Mead National Recreation Area under MSHCP project 2005-NPS-535-P, establishing

long-term monitoring at three populations: Sandy Cove, Ebony Cove, and Weiser Wash (NPS 2010). At Sandy Cove, the largest known population and the southern extension of the species' range, the number of threecorner milkvetch individuals declined from 3,968 plants in 2008 to 2,027 plants in 2009, and total quadrat-level cover at Sandy Cove was also significantly lower in 2009 than in 2008 (NPS 2010). Native cover was high relative to non-native cover at all three sites, but non-native cover was substantially higher in 2009 at Weiser Wash than at the two NPS-managed sites, a pattern the authors attributed to limited Sahara mustard control on BLM lands at Weiser Wash compared with active and consistent invasive species management on NPS lands (NPS 2010). Inventory effort conducted in parallel with the monitoring also documented a previously unreported occurrence on NPS land near Valley of Fire Wash on April 13, 2009, with an estimated 50 to 100 plants, plus two additional plants at a nearby point; this occurrence may represent an extension of the historical Valley of Fire population group (NPS 2010). The report emphasized that Mediterranean grass (*Schismus* sp.) was stabilizing active portions of the dunes at Sandy Cove, and that continued spread of this and other invasive annual grasses could eventually alter the loose-sand habitat sufficiently to drive population declines (NPS 2010).

In parallel with the NPS monitoring effort, ICF Jones & Stokes (2010) conducted Desert Conservation Program-funded rare plant inventories at 511 randomly selected survey plots distributed across thirteen geographic units in Clark County, using standardized field protocols designed to support predictive ecological modeling for ten covered rare plant species. Field surveys were conducted between April 2, 2009 and May 23, 2010. Threecorner milkvetch was detected nine times during these surveys, with seven observations made within survey plots and two recorded incidentally while teams were traveling to or from plots (ICF Jones & Stokes 2010). Rainfall during the winter of 2008 and spring of 2009 was close to normal, and annual species, including threecorner milkvetch, were evident at reference populations during the survey period, indicating that survey results during this effort are reliable for detecting the species where it occurred (ICF Jones & Stokes 2010).

Clark County Desert Conservation Program Rare Plant Surveys conducted by Ironwood Consulting document the recent severe impacts of the ongoing megadrought on threecorner milkvetch populations. In the 2020 Rare Plant Survey Report, threecorner milkvetch was detected at 14 locations within six survey areas: Halfway Wash, Logandale Trails, Moapa Indian Reservation, South Mormon Mesa, St. Thomas Point, and Virgin River. These populations were ranked fair to excellent in health and encompassed a total of approximately 4 acres of occupied area with approximately 259 individuals (Ironwood Consulting 2020).

During the 2021 surveys, threecorner milkvetch was not detected at any previously known locations, despite targeted surveys of suitable habitat. The absence was attributed to drought conditions: the Las Vegas area received only approximately 2.4 inches of precipitation in 2020 and 1.9 inches in 2021, both well below the 30-year average of 4.2 inches. The above-average precipitation in 2019 (6.9 inches) is believed to have stimulated germination during the spring 2020 season, while two consecutive below-average years resulted in an absence of annual plants and reduced vigor of perennials in 2021 (Ironwood Consulting 2021). No individuals were detected during 2022 surveys.

In 2023, threecorner milkvetch was documented at East Mormon Private and West Mormon 2 survey areas. Both locations represent new occurrence records, and the populations were observed to be fair in health, largely due to the small number of diminutive individuals present at each location. A total of 14 individuals were documented across approximately 0.1 acres (0.04 hectares) of occupied area. Mean elevation ranged from 399 to 509 meters (1,309 to 1,669 feet). Both occurrences fell within areas

modeled as optimal habitat suitability. Common associated species recorded at both occurrences included gravel milkvetch (*Astragalus sabulonum*), big galleta (*Hilaria rigida*), large desert evening primrose (*Oenothera deltoides*), and apricot mallow (*Sphaeralcea ambigua*). Invasive weed cover was relatively low at both locations (Ironwood Consulting 2023).

Summary counts across the Clark County Desert Conservation Program surveys document the magnitude of precipitation-driven variation: approximately 250 plants were documented across 14 sites in 2020; zero plants were detected in 2021 and 2022; and 14 plants were detected at two sites in 2023 (Ironwood Consulting 2020, Ironwood Consulting 2021, Ironwood Consulting 2023). The 2023 detections are consistent with the species' known precipitation dependence: after two consecutive below-average precipitation years (2021 to 2022), the comparatively wetter 2022 to 2023 season triggered limited germination, though total annual precipitation remained approximately half the amount recorded during the 2019 to 2020 season (Ironwood Consulting 2023).

These survey findings are consistent with USGS seed ecology research conducted from 2020 to 2022, which found no live *Astragalus geyeri* var. *triquetrus* plants at any of the 17 known population groups during field surveys, and no seeds of the species in soil seed bank samples from four populations (California Wash, Mud Lake, Bark Bay, Sandy Cove). No seedlings emerged during a nine-month greenhouse incubation of habitat soils, and no seeds of the species were recovered from soil samples sieved at the end of the incubation period, indicating that the species was extremely rare or absent from the seed bank during the prolonged drought period (DeFalco et al. 2023).

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Blue Diamond Cholla (*Cylindropuntia multigeniculata*)

Photo Credit: Stefanie Ferrazzano, Clark County

Photo Credit: Ironwood Consulting

Species Overview

Blue Diamond cholla (*Cylindropuntia multigeniculata*) is a member of the cactus family (Cactaceae); it is a shrubby, densely branched cactus up to 0.5 meter tall and 1.5 meters broad, with stems composed of 30 to 40 cylindrical segments (Baker 2005, Scoles-Sciulla et al. 2023). Individuals of this cactus occur on limestone soils near the type locality west of Las Vegas as well as volcanic soils derived from basalt and granite for other populations. Aspect varies across known sites, and plants are typically associated with steep, dry, rocky slopes or washes with large rocks or boulders and with minimal vegetation cover (Baker 2005). Individuals of this species may be associated with overlying gypsum beds located up-slope and typically co-occur with succulents and shrubs in vegetation dominated by creosote bush or blackbrush (NNHP 2000).

Blue Diamond cholla is recognized as a full species (Baker and Cloud-Hughes 2014), despite previous descriptions of hybridization with other closely related species. It was formerly named *Opuntia whipplei* (Engelmann and Bigelow) var. *multigeniculata*. Taxonomic uncertainty surrounding this species persists due to its history of hybridization with related chollas and its historically limited distribution data; however, morphological and cytological analyses by Baker (2016) concluded that *C. multigeniculata* represents a group of populations with distinctive morphological traits suggesting it is not of hybrid origin and is worthy of taxonomic recognition at the species level.

Plants with morphology intermediate between Blue Diamond cholla and buckhorn cholla (*Cylindropuntia acanthocarpa*) are frequently observed where the two taxa co-occur, and these putative hybrids morphologically resemble silver cholla (*Cylindropuntia echinocarpa*), although no morphological intermediates between Blue Diamond cholla and silver cholla have been documented (Baker and Cloud-Hughes 2014; Ironwood Consulting 2024). Fruit spine expression also varies geographically across the species' range: plants lacking spines on the fruit occur in the Desert National Wildlife Refuge and at the Blue Diamond type locality, plants with the spiniest fruit occur in Gold Butte National Monument and adjacent Arizona, and populations with intermediate fruit types occupy the region between (Baker 2016; Ironwood Consulting 2024). Whether this variation reflects past hybridization, recent adaptation to arid conditions, or evolutionary divergence among populations remains unresolved. Because spineless-fruited individuals can be confused with Whipple cholla (*Cylindropuntia whipplei*) and spiny-fruited individuals can be mistaken for silver cholla, positive field identification requires a combination of

morphological characters, particularly in areas where the ranges of these species overlap (Ironwood Consulting 2024).

Range

Based on the recent taxonomic change, this species is thought to occur only within Clark County, Nevada, with potential encroachment over the border into Mohave County, Arizona (NatureServe 2026). The global range extent is estimated at 1,000 to 5,000 square kilometers (NatureServe 2026). Within Clark County this species has been reported north of Blue Diamond, Nevada (type locality), in Sloan Canyon, near Gass Peak, and in Gold Butte near Bonelli Peak (Baker 2005, Nussear et al. 2011, Baker and Cloud-Hughes 2014). More recent surveys have substantially expanded the known distribution of Blue Diamond cholla in Clark County, pushing the northern range limit to within approximately 16 kilometers of Lincoln County, Nevada, and the eastern limit to within a few kilometers of the Arizona border (Ironwood Consulting 2024).

Habitat Characteristics

Habitat for this species is predominantly in Mojave Desert Scrub, Blackbrush, and Pinyon Juniper ecosystems, but potentially includes Salt Desert Scrub. Blue Diamond cholla occurs in Joshua tree (*Yucca jaegeriana*) woodland and Mojave Desert scrubland associations including creosote bush (*Larrea tridentata*), white bursage (*Ambrosia dumosa*), blackbrush (*Coleogyne ramosissima*), and *Yucca* species on rocky limestone, basalt, granite, and rhyolite soils, primarily on rocky slopes where perennial shrub cover is low (approximately 5 to 15 percent) (Baker 2005, 2016; Scoles-Sciulla et al. 2023).

A broad elevational range for Blue Diamond cholla has been recorded, from as low as 2,001 feet (Baker 2005) up to 4,249 feet (NNHP 2000), with Nussear et al. (2011) reporting a range of 2,592 to 4,659 feet in their habitat suitability modeling. More recent survey data document Blue Diamond cholla at elevations ranging from 999 to 1,775 meters (3,278 to 5,824 feet) across Clark County (Ironwood Consulting 2021, 2024). The species is typically found on steep slopes and rocky ledges composed of a mixture of limestone, dolostone, gypsiferous red shale, and claystone (Scoles-Sciulla et al. 2023).

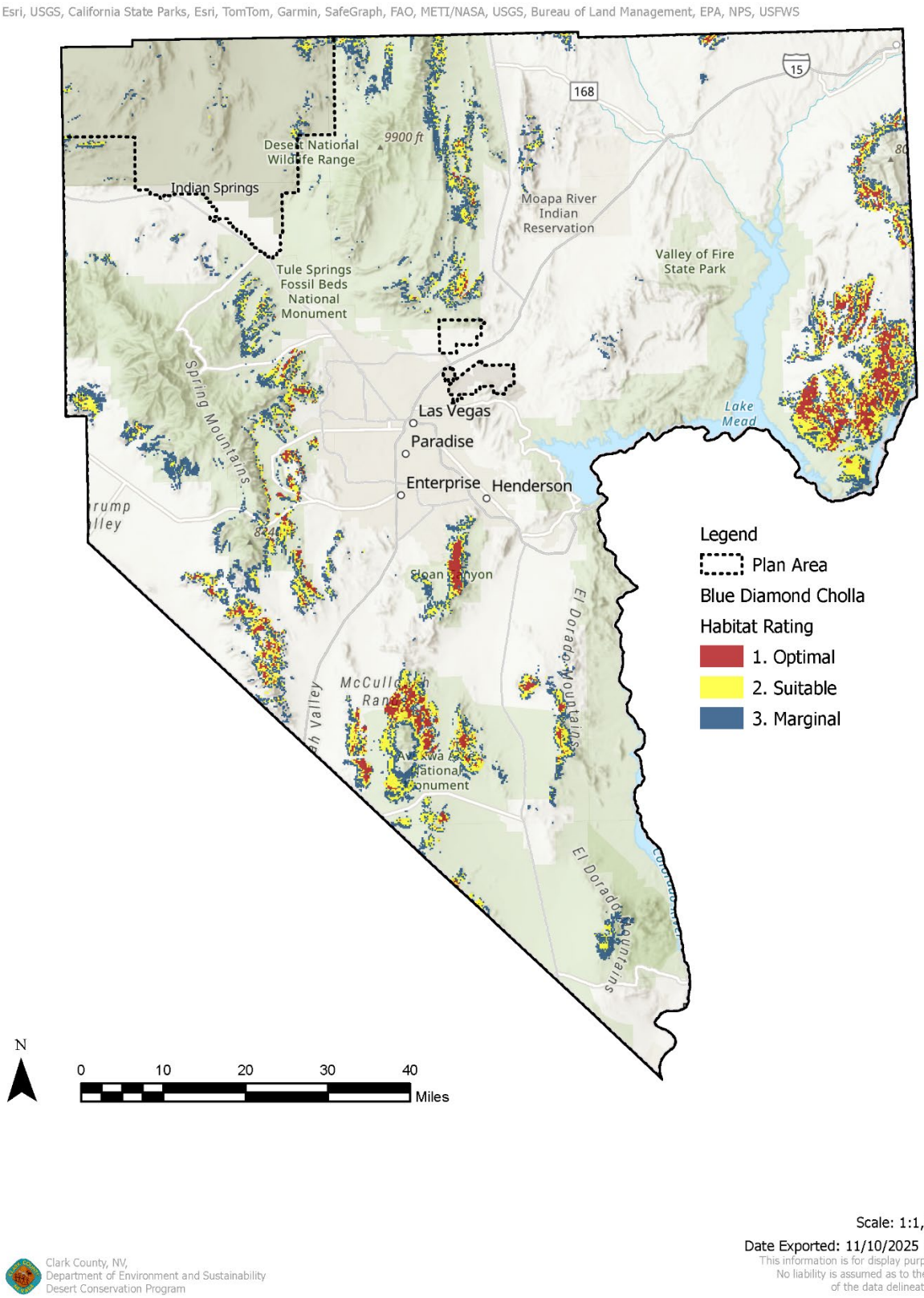
Habitat Suitability Model

Simandle and Nussear (2025) developed an ensemble habitat suitability model for Blue Diamond cholla within the Clark County vegetation divisions. Locality data for the species consisted of 52,587 records within the buffered modeling area, which were spatially thinned to 1,164 records for training and testing. The ensemble model demonstrated strong performance, with a testing Area Under the Receiver Operating Curve of 0.9999 (SD 0.0003), a TSS of 0.9981 (SD 0.0083), and a CBI of 0.9476 (SD 0.0607) (Simandle and Nussear 2025). The continuous BI indicated that once predicted suitability exceeded approximately 80 percent, observed presences occurred up to 50 times more often than expected by chance.

The most influential predictors in the ensemble model were depth to bedrock, silica index, fractional cover of bare ground, and soil pH. Suitability was high where bedrock was shallow (roughly less than 1,000 meters) and declined sharply at greater depths. The silica index elevated suitability when values exceeded 1.05. Bare ground cover supported high suitability when below 75 percent and declined above that threshold. Soil pH was associated with low suitability below pH 7, with suitability increasing as pH rose above 7 (Simandle and Nussear 2025). An alternative ensemble model run across the buffered modeling area (without Clark County vegetation divisions) identified similar top predictors, including

depth to bedrock, coefficient of variation in winter precipitation (peak near 0.7), absolute minimum temperature (highest suitability between -5 and 0 degrees Celsius), and the silica index (Simandle and Nussear 2025).

Areas of high habitat suitability for Blue Diamond cholla are broadly distributed across Clark County (Figure 23). High suitability generally occurs at mid-elevations, whereas suitability is low in valleys, lowlands, and at the highest elevations. Highly suitable habitat is found around the periphery of the Sheep Range and adjacent areas of the Las Vegas Range, in the Muddy Mountains, along the Spring Mountains, and in the McCullough Range. Within the buffered area, highly suitable habitat is also apparent in the Nopah Range, Mesquite Mountains, Kingston Range, and New York Mountains in California, and in the Black Mountains and Grapevine Mesa in Arizona (Simandle and Nussear 2025).



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Clark County, NV,
Department of Environment and Sustainability
Desert Conservation Program

Figure 23. Habitat suitability model for Blue Diamond cholla (*Cylindropuntia multigeniculata*) in Clark County, Nevada (Simandle and Nussear 2025).

Species Status

Agency/Organization	Status
MSHCP (2000)	Covered
U.S. Fish and Wildlife Service Endangered Species Act	None*
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	Fully Protected
State of Arizona	Salvage Restricted
NV Natural Heritage Program (2025)	G2 S2
NV Climate Change Vulnerability Index	Not Addressed
IUCN Red List (v 2025-2)	Least Concern
CITES	Appendix II

* Removed from the candidate list based on management and habitat conservation agreements (USFWS 2001).

Blue Diamond cholla holds a global NatureServe status of G2 (Imperiled), with a national status of N2 in the United States. State-level rankings are S2 in Nevada and S2S3 in Arizona (NatureServe 2026). The species is listed under CITES Appendix II, it is a BLM Special Status Species, and it is fully protected in the State of Nevada. Cylindropuntia multigeniculata was a candidate species under the Endangered Species Act in 1999 but was removed from the candidate list in 2001 based on active management of lands and the execution of the multiple species conservation plan agreement (USFWS 1999, 2001; Scoles-Sciulla et al. 2023). As of the most recent NatureServe review (July 2021, updated 2026), no substantive change in global or state rank has been recorded.

Population Trends

As of 2016, a total of 10 populations of Blue Diamond cholla were known, with 9 of the 10 appearing healthy and free of immediate threats (NatureServe 2026). The NatureServe Network Database (as of July 2021) included 7 Nevada occurrences and 3 Arizona occurrences. Baker (2016) mapped 6 occurrences in Nevada and 2 in Arizona. At least a portion of the Blue Diamond population at the type locality was threatened by development (Baker 2005).

Recent surveys have substantially expanded both the known distribution and estimated population size for Blue Diamond cholla in Clark County. Combined 2020, 2021, 2022, and 2023 survey efforts by Ironwood Consulting documented thousands of individuals across tens of thousands of acres, with the 2023 fieldwork alone adding approximately 38,068 individuals previously unknown to science. These findings raise the total estimated population well above the 56,500 individuals cited in the 2005 status report (Baker 2005; Ironwood Consulting 2024). Based on these substantial distributional updates, Ironwood Consulting (2024) recommended a formal review of all Blue Diamond cholla occurrence records by a rare plant technical committee to evaluate whether the current State of Nevada listing status remains appropriate.

Habitat Level Threats

Primary habitat-level threats to Blue Diamond cholla include gypsum mining, road construction, and commercial development, particularly near the type locality at Blue Diamond Hill (Baker 2005; NatureServe 2026). The type locality at Blue Diamond Hill has been threatened by mining, residential development, and the proposed construction of a hydroelectric plant over the past two decades (Baker 2005). Wildfire and broader habitat loss have also affected Blue Diamond cholla habitat (Baker 2005). Due to the rocky and steep terrain it occupies, this species is unlikely to be significantly impacted by off-highway vehicle activity. Desert fires have previously affected Blue Diamond cholla and will continue to be an ecosystem threat; however, the steep, rocky terrain also provides some inherent protection due to the sparseness of vegetation. The lack of fuel continuity makes fires patchier in such habitats and thus less prone to widespread damage.

Invasive annual grasses such as red brome (*Bromus rubens*), cheatgrass (*Bromus tectorum*), and Mediterranean grass (*Schismus* spp.) have been documented co-occurring with Blue Diamond cholla at multiple sites, raising concern about future wildfire risk (Ironwood Consulting 2021, 2024). Evidence of previous fire was noted at occurrences at Summit Pass and one North Clark County site, and at least one 2020 occurrence showed evidence of an extensive recent wildfire on adjacent ridgelines that likely eliminated much of the population prior to the survey (Ironwood Consulting 2020, 2021). Climate change is expected to influence the frequency and intensity of drought and wildfire events across the Mojave Desert, with potential consequences for Blue Diamond cholla habitat suitability at the margins of the species' elevational and climatic range.

Fire size and frequency in the southwestern United States have increased in recent decades, driven in part by the presence and density of invasive annual plants and the resulting grass-fire feedback cycle, in which fine fuel loading from invasive annuals sustains larger wildfires that can diminish or eliminate fire-intolerant perennials (Shryock et al. 2015, as cited in Ironwood Consulting 2024). Cactus species generally show reduced abundance in burned areas relative to unburned areas, and several traits limit their post-fire recovery: most cacti do not survive direct fire because of tissue desiccation, typically lack persistent soil seed banks, and experience relatively high seed mortality during fires (Shryock et al. 2014; Esque et al. 2010, as cited in Ironwood Consulting 2024). Juvenile cholla in particular have been documented to experience elevated post-fire mortality (Parmenter 2008, as cited in Ironwood Consulting 2024). Together these traits suggest that Blue Diamond cholla populations are susceptible to significant losses from medium- to high-intensity wildfires or from repeated burning at short fire-return intervals, although surveyors have anecdotally observed recruitment of young plants in burned habitat and persistence of often mature individuals in habitat refugia such as cliff bands and rocky areas that were apparently unburned or burned under low-severity conditions (Ironwood Consulting 2024).

Threats to Species

Direct threats to Blue Diamond cholla include illegal horticultural collection, which is explicitly identified by NatureServe (2026) as a primary threat alongside gypsum mining. In Nevada, the species is impacted at one site by a gypsum mine and is vulnerable to horticultural collecting, although most sites are under public protective management (NNHP 2007, as cited in NatureServe 2026). Fully protected status under Nevada state law and the species' CITES Appendix II listing provide regulatory mechanisms to limit collection, but enforcement at remote sites may be limited.

Taxonomic uncertainty surrounding Blue Diamond cholla, due to its documented hybridization with other closely related *Cylindropuntia* species particularly near range boundaries, may complicate species identification during field surveys and could affect the accuracy of distributional records. The species' preference for steep, rocky terrain also presents logistical challenges for survey efforts, as many occupied sites are difficult to access on foot. Direct fire mortality remains a species-level threat where wildfire penetrates occupied patches, as documented at Summit Pass and other sites (Ironwood Consulting 2021).

Reproductive biology considerations may also influence species-level vulnerability. Scoles-Sciulla et al. (2023) found that Blue Diamond cholla has 30 to 40 joint segments per stem, a trait associated with low rates of joint establishment across *Cylindropuntia* species. Their shade house propagation study documented approximately 50 percent mortality of joint cuttings during the first month, with overall establishment of 25 percent at 5 months, suggesting that *C. multigeniculata* relies more heavily on sexual reproduction than on vegetative (joint) propagation. Erratic precipitation patterns typical of desert ecosystems can reduce seed set and viability, creating uncertainty about recruitment reliability and complicating population recovery in disturbed habitats (Scoles-Sciulla et al. 2023).

Conservation and Management

Within the Red Rock Canyon National Conservation Area, multi-agency and stakeholder agreements have been put in place to protect habitat for this species by limiting mining development and by implementing fire prevention and suppression plans (BLM 2005). This species also inhabits the Sloan Canyon National Conservation Area and is similarly protected (BLM 2009). A conservation agreement designed to reduce threats to this species and its habitat was a key factor in its removal from the Endangered Species Act candidate list (USFWS 2001). This agreement consists of provisions within the conservation plan for Red Rock National Conservation Area and is designed to protect 83 percent of its known habitat (RECON 2000, BLM 2005). Legislation passed in 2013 supported land exchanges to protect habitat for this species near the type locality within Red Rock (Nevada Senate Bill 159 2013).

Propagation and reintroduction of Blue Diamond cholla from joint cuttings has been evaluated as a potential conservation technique. Scoles-Sciulla et al. (2023) demonstrated that propagation from joint cuttings is viable, with a 50:50 inorganic to organic soil mix producing greater shoot and root biomass, more joint segments, and higher survivorship than an 85:15 mix. Frequent watering with small volumes of water produced longer roots compared with infrequent watering, a pre-conditioning trait that may improve outplant survival in the species' dry native habitats. These findings support propagation-based mitigation or reintroduction efforts for the species, although reintroduction field trials are needed to confirm long-term outplant survival.

The greater survival and growth of joint cuttings observed in the organic-rich soil mix further suggests that nurse plants, around which soil organic matter and nutrients tend to concentrate in desert ecosystems, may benefit survival and growth of outplanted cuttings in the field (Scoles-Sciulla et al. 2023). A clearer understanding of the habitat requirements and microsite associations of the species, combined with selection of an appropriate reintroduction season and use of nurse-plant microsites, would support conservation efforts. Ironwood Consulting (2024) further recommended longer-term research to evaluate short- and long-term effects of wildfire and competition with invasive annual plants on Blue Diamond cholla populations, including the establishment of long-term monitoring plots in burned habitat and adjacent unburned areas at candidate sites such as the Desert National Wildlife Refuge and Gold Butte National Monument. Tracking variables such as germination, census, age

structure, and plant cover (including invasive annuals) over time would help fill knowledge gaps about the species' resilience to fire and to increased presence of annual invasive plants, and would inform future management and conservation decisions.

Within the MSHCP Amendment Plan Area, approximately 185,470 acres of suitable Blue Diamond cholla habitat have been identified (Simandle and Nussear 2025). Of this total, 352 acres (0.2 percent) occur within the MSHCP Amendment Impact Area. Approximately 155,431 acres (83.8 percent) are located on lands managed for resource conservation, and 7,281 acres (3.9 percent) occur within the MSHCP Amendment Reserve System Additions. No suitable habitat (0.0 percent) occurs within the existing MSHCP Reserve System.

Blue Diamond cholla (*Cylindropuntia multigeniculata*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	185,470	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	352	0.2%
Suitable Habitat in Lands Managed for Resource Conservation	155,431	83.8%
Suitable Habitat in the existing MSHCP Reserve System	0	0.0%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	7,281	3.9%

*Simandle and Nussear 2025

Clark County Survey Data

Rare plant surveys conducted by Ironwood Consulting in 2020 detected Blue Diamond cholla at a single location within the Frozen Toe Road survey area. This occurrence included 91 individuals inhabiting 0.46 acre of occupied area at elevations between 1,375 and 1,469 meters (4,511 to 4,819 feet), with an overall quality rating of good. The plant community at this site was dominated by *Prunus fasciculata*, *Purshia stansburiana*, and *Yucca brevifolia*. Surveyors noted that evidence of an extensive recent wildfire on adjacent ridgelines likely eliminated much of the population prior to the survey, with ridgetops appearing to have served as refugia during the fire event (Ironwood Consulting 2020).

The 2021 rare plant survey observed Blue Diamond cholla at six locations in Clark County: three within North Clark County, one in the Desert National Wildlife Refuge, one in the McCullough Mountains, and one in Summit Pass (Ironwood Consulting 2021). Combined, these six occurrences yielded an estimated total of more than 16,772 individuals across approximately 1,428 acres (578 hectares) of occupied area, with elevations ranging from 999 to 1,775 meters (3,278 to 5,824 feet). Overall quality ratings ranged from good to excellent. Notably, all six occurrences were located within areas initially modeled (as modeled by SWECO 2018) as low-to-medium habitat suitability; none fell within high-suitability modeled habitat, suggesting the initial species distribution model would benefit from additional training data for this species. The largest single occurrence at Summit Pass within Gold Butte National Monument contained an estimated 14,000 individuals across 1,001.5 acres and represents the largest contiguous known population of the species; the full extent of this occurrence had not yet been completely mapped at the time of the survey. Common associates across 2021 occurrences included *Cylindropuntia acanthocarpa*, *Ephedra nevadensis*, *Prunus fasciculata*, *Senegalia greggii*, *Yucca baccata*, and *Yucca brevifolia*. Invasive annuals *Bromus tectorum* and *Schismus* sp. were co-occurring at several sites, raising

concern about future wildfire risk; evidence of previous fire was noted at occurrences at Summit Pass and one North Clark County site (Ironwood Consulting 2021).

Additional targeted surveys for Blue Diamond cholla were conducted in fall 2022 and spring and fall 2023 (Ironwood Consulting 2022, 2024). Surveys were guided by the initial habitat suitability model, and 17 general survey areas were identified, totaling approximately 49,934 acres across Clark County.

The 2022 surveys covered five areas (Bird Spring Range, Keystone Wash Prospects, Lost Cabin Spring, Manse, and Trout Canyon North), encompassing approximately 22,894 total acres, including 12,675 acres of modeled habitat. No Blue Diamond cholla individuals were detected during the 2022 field effort (Ironwood Consulting 2022).

The 2023 surveys targeted the remaining 12 general survey areas, adding an opportunistic survey at Gann/Walker Spring, and covered approximately 44,483 total acres, including 29,233 acres of modeled habitat. Five new records for Blue Diamond cholla were documented at the Wamp Spring, Gann/Walker Spring, Jumbo, and Summit Pass survey areas. Combined, these occurrences encompassed approximately 5,154 acres of occupied habitat and an estimated 52,068 individuals. The largest single occurrence at Summit Pass, where surveys added an estimated 34,000 individuals and 2,486 acres of occupied habitat to the previously delineated boundary, brought the total estimated population at that site alone to more than 48,000 individuals across approximately 3,488 acres. The mean elevation range across 2023 occurrences was 787 to 1,573 meters (2,582 to 5,160 feet). Common associates included blackbrush (*Coleogyne ramosissima*), catclaw acacia (*Senegalia greggii*), creosote (*Larrea tridentata*), ephedra (*Ephedra* spp.), Mojave yucca (*Yucca schidigera*), and red brome (*Bromus rubens*). Habitat quality ranged from fair to good, with wildfire evidence and invasive annual plants identified as the primary threats at occupied sites.

Combined 2022 and 2023 surveys substantially expanded the known distribution of Blue Diamond cholla in Clark County. The 2023 fieldwork documented nearly 38,068 additional individuals previously unknown to science, raising the total estimated population well above the 56,500 individuals cited in the 2005 status report (Baker 2005). Ironwood Consulting (2024) recommended a formal review of all Blue Diamond cholla occurrence records by a rare plant technical committee to evaluate whether the current State of Nevada and Clark County listing status remains appropriate.

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Silverleaf Sunray (*Enceliopsis argophylla*)

Photo Credit: Stefanie Ferrazzano, Clark County

Photo Credit: Stefanie Ferrazzano, Clark County

Species Overview

Silverleaf sunray (*Enceliopsis argophylla*) is a low-growing perennial forb in the Asteraceae family, recognized by its silvery gray-green, blade-shaped leaves that form basal clumps, and its bright orange-yellow flower heads borne on leafless stalks (Welsh et al. 2015). Leaves can reach up to 8 centimeters wide and 12 centimeters long, and flower heads are typically 3 to 6 centimeters across. Silverleaf sunray is very similar in appearance to the more common nakedstem sunray (*Enceliopsis nudicaulis*), but is distinguished by wider, winged, shorter petioles and by its distinct geographic range (Welsh et al. 2015). The species flowers from April to June (AGFD 2021). Silverleaf sunray is one of four species in the genus *Enceliopsis* (Sanders and Clark 1987).

Silverleaf sunray is the host plant for the Mojave gypsum bee (*Andrena balsamorhizae*). Adult bees nectar on multiple plant species, but the larvae require pollen from silverleaf sunray (Griswold et al. 2006). The type locality for the species was reportedly near St. Thomas, Nevada, and has been inundated by Lake Mead for nearly 80 years (Cronquist 1994).

Range

Silverleaf sunray is a rare plant nearly entirely restricted to a small portion of Clark County, Nevada (NatureServe 2026), with limited occurrences reported from Washington County, Utah (Cronquist 1994) and Mohave County, Arizona (McDougall 1973, Morefield 2001, Griswold et al. 2006). The species is broadly associated with the vicinity of Lake Mead and occurs from approximately 1,000 to 1,500 meters in elevation, although it has been recorded as low as 350 meters in Nevada (NNHP 2001, FNA 2006). Records from Utah are considered uncertain; the type specimen was reportedly collected in 1870 at St. George, Utah, but this collection may have originated from southern Nevada or may be better attributed

to the closely related *E. nudicaulis* (Welsh et al. 2015, NatureServe 2026). Additional survey and taxonomic work is needed to clarify the species' distribution in the Beaver Dam Mountains region of Utah and northern Arizona (NatureServe 2026).

NatureServe (2026) estimates 61 occurrences rangewide based on herbarium specimens, photo-based observations, and NatureServe Network occurrence data collected between 1994 and 2025. The majority of these occurrences are located in and around Lake Mead National Recreation Area. Range extent has been estimated at 5,000 to 20,000 square kilometers, with an area of occupancy of approximately 84 two-kilometer grid cells (NatureServe 2026).

In Nevada, silverleaf sunray occurs only in Clark County and is found from the River Mountains east of Henderson to Echo Bay and the Las Vegas Wash, largely within Lake Mead National Recreation Area (Kartesz 1988). The species predominantly occurs on federal lands, including Lake Mead National Recreation Area and Gold Butte National Monument. Some historic silverleaf sunray occurrences in Utah and Arizona have been reclassified as *E. nudicaulis* (NatureServe 2026).

Habitat Characteristics

Silverleaf sunray occupies desert habitats characterized by clay and gypsum cliffs, gravelly slopes, sandy washes, and stony plains and hillsides at elevations generally between 1,000 and 1,500 meters (Kartesz 1988, FNA 2006). In Nevada, the species is found in "dry, open, relatively barren areas on gypsum badlands, volcanic gravels, loose sands, etc., in the creosote-bursage zone" (NNHP 2001). In Arizona, the species occurs on limestone substrates in desert scrub in association with *Arctomecon*, *Atriplex* spp., *Chilopsis linearis*, *Coleogyne ramosissima*, *Dalea*, *Ephedra*, *Larrea tridentata*, and others (AGFD 2021). Habitat is described by NatureServe as narrow, with key requirements relatively common within the species' limited range (NatureServe 2026).

The largest populations documented in Clark County occur on gypsum soils with thick biotic crusts, often in the same areas as Las Vegas bearpoppy (*Arctomecon californica*); however, silverleaf sunray also occurs commonly in gypsic areas with thin or no biotic crusts and has not been recorded on rocky areas (Bangle et al. 2010). Soils supporting silverleaf sunray are fragile and sensitive to surface disturbance.

Common perennial plant species associated with silverleaf sunray in Lake Mead National Recreation Area and surrounding lands include catclaw acacia (*Senegalia greggii*), white bursage (*Ambrosia dumosa*), Las Vegas bearpoppy, sticky ringstem (*Anulocaulis leiosolenus*), Preuss' milkvetch (*Astragalus preussii*), fourwing saltbush (*Atriplex canescens*), desert holly (*Atriplex hymenelytra*), brittlebush (*Encelia farinosa*), Torrey ephedra (*Ephedra torreyana*), desert trumpet (*Eriogonum inflatum*), creosote bush, desert pepperweed (*Lepidium fremontii*), Parry sandpaper plant (*Petalonyx parryi*), big galleta (*Pleuraphis rigida*), Fremont indigo bush (*Psorothamnus fremontii*), and desert globemallow (*Sphaeralcea ambigua*) (Bangle et al. 2010).

Habitat Suitability Model

Habitat suitability for silverleaf sunray in Clark County was modeled by Nussear et al. (2024) using an ensemble modeling approach that combined generalized additive models, gradient boosted machines, MaxEnt, and random forests. Both a base model (excluding vegetation) and a vegetation-inclusion model were developed. The base ensemble model performed very well, with an area under the curve of 1.00 for training data and 0.99 for testing data, a continuous BI of 0.99 for training data and 0.95 for testing data, and a true skill statistic of 0.97 for training data and 0.88 for testing data (Nussear et al. 2024). The

vegetation-inclusion ensemble also exhibited high performance, with AUC values of 1.00 for training and 0.98 for testing data, BI values of 0.91 and 0.77, and TSS values of 1.00 and 0.89, respectively. Among the component algorithms in the base model, GAM had slightly lower performance on the BI for the testing dataset, and GBM also scored lower on the BI for testing data compared to other algorithms (Nussear et al. 2024).

The most influential environmental variables in the base ensemble model were winter precipitation, winter minimum temperature, and gypsum potential, with contributions distributed most evenly in the GAM and random forest components. The MaxEnt model was driven almost entirely by topographic roughness (TRI), and the GBM model was driven largely by winter minimum temperature and gypsum potential. NDVI measures had the lowest contributions among predictors evaluated. In the vegetation-inclusion models, gypsum potential contributed most strongly to the GBM algorithm, while the random forest algorithm distributed importance more evenly among vegetation, winter minimum temperature, NDVI maximum, gypsum potential, surface texture, roughness, and winter precipitation (Nussear et al. 2024). The vegetation associated with silverleaf sunray localities was predominantly North American Warm Desert Scrub and Grassland, with smaller contributions from Western North American Cool Semi-Desert Scrub and Grassland (Nussear et al. 2024).

Predicted habitat suitability for silverleaf sunray is broadly distributed throughout north-central Clark County, including the north shore of Lake Mead (Figure 24). The base model and vegetation-inclusion model produced similar spatial patterns, although the vegetation-inclusion model predicted a reduction in suitable habitat in the southern portion of the county (Nussear et al. 2024). High-suitability habitat is concentrated in gypsum-influenced landscapes in the vicinity of Lake Mead National Recreation Area, consistent with documented occurrence records.

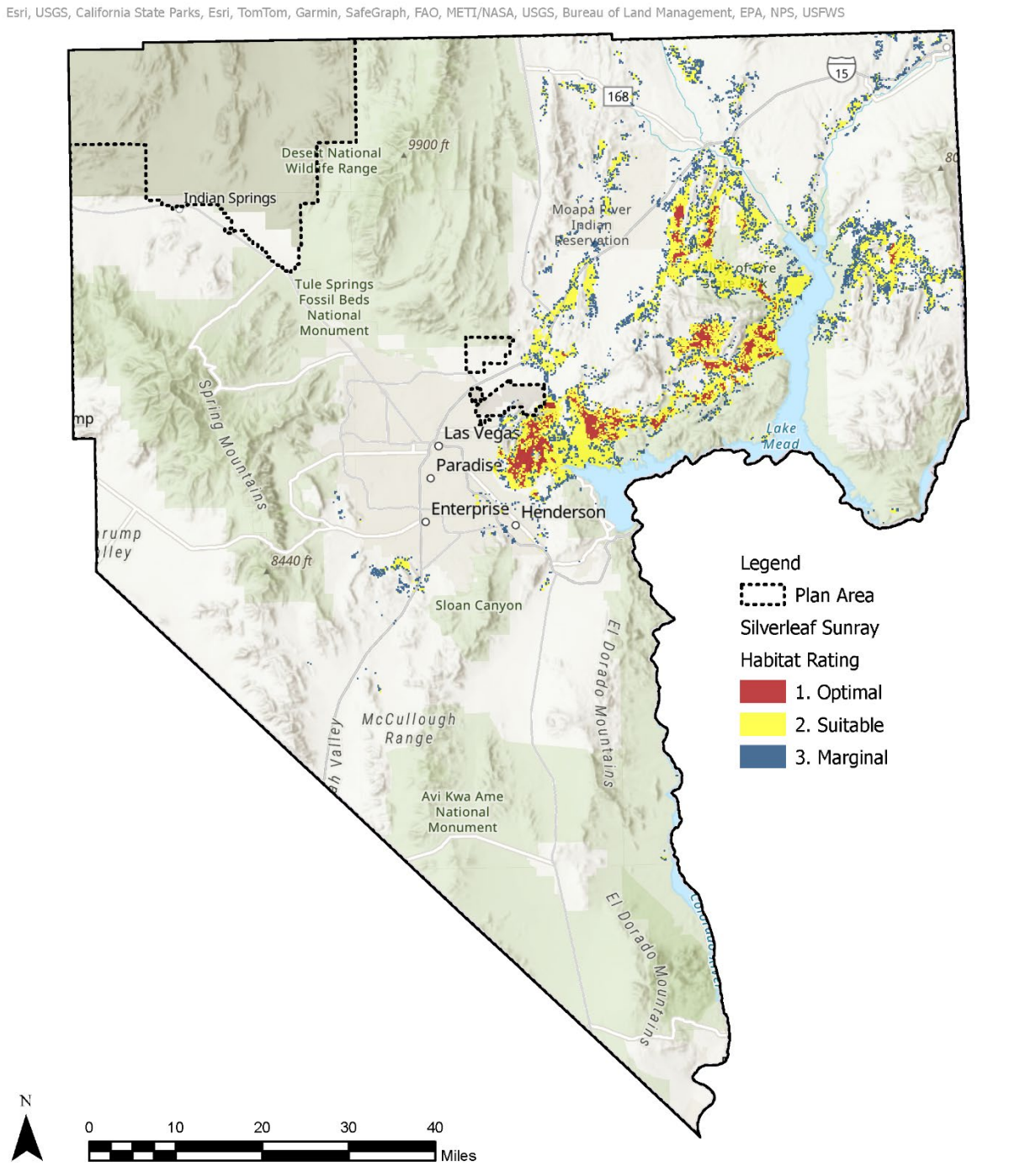

Figure 24. Habitat suitability model for silverleaf sunray (*Enceliopsis argophylla*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Evaluation
U.S. Fish and Wildlife Service Endangered Species Act	None
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	None
State of Arizona	None
State of Utah	None
NV Division of Natural Heritage	At Risk
NV Climate Change Vulnerability Index	Not Addressed
NatureServe Global and NV State Rank	G3 S2
IUCN Red List	None
CITES	None

Silverleaf sunray has no status under the Endangered Species Act. NatureServe (2026) assigns the species a global conservation status of G3 (Vulnerable), last reviewed February 13, 2025, with state ranks of S2 (Imperiled) in Nevada and Arizona, and S1 (Critically Imperiled) in Utah. The national rank for the United States is N3. Silverleaf sunray is designated a Sensitive Species by the BLM in Nevada and a Nevada Natural Heritage Program At-Risk species (NNHP 2025). The species has no status under CITES or the IUCN Red List (NatureServe 2026).

NatureServe (2026) cites the species' narrow range, limited number of occurrences, and potential threats from recreational activities as the basis for its G3 global rank. An estimated 61 occurrences are documented rangewide, with the majority concentrated near Lake Mead National Recreation Area. Little is known about population trends or the severity of threats, and NatureServe identifies monitoring of populations as important to improving the understanding of the status of silverleaf sunray.

Population Trends

Long-term and short-term population trends for silverleaf sunray are unknown (NatureServe 2026). No viability assessments have been completed for occurrences tracked by NatureServe Network programs, and no systematic long-term monitoring data are available for the species. NatureServe (2026) notes that silverleaf sunray can be locally common within a restricted range in Nevada, and that numerous occurrences have been documented in and around the Lake Mead area.

Surveys conducted by the NPS at Lake Mead National Recreation Area from 2008 to 2010 documented range expansion along recently reconstructed portions of Northshore Road and below the receding high-water mark at Government Wash and Stewart's Point, suggesting the species is capable of recruiting into newly disturbed or newly exposed suitable habitat (Bangle et al. 2010). Observations of seedlings and

juveniles in portions of Lake Mead National Recreation Area indicated healthy recruitment during that survey period (Bangle et al. 2010). More recent rare plant surveys conducted by Ironwood Consulting for the Clark County Desert Conservation Program from 2020 through 2023 documented 17 new element occurrence records in Clark County (Ironwood Consulting 2020, 2021, 2023). Additional long-term monitoring is needed to characterize population trends with confidence.

Habitat Level Threats

The primary habitat-level threat to silverleaf sunray is physical disturbance of the fragile gypsum and sandy soils on which the species depends. Off-highway vehicle use off designated routes on BLM lands has been identified as a threat to silverleaf sunray habitat (NatureServe 2026, Ironwood Consulting 2020, 2021, 2023). Disturbance compacts soils, damages biotic crusts, and can fragment habitat patches. Silverleaf sunray populations frequently occur near established roads, and off-highway vehicle tracks have been observed running through occupied habitat (Bangle et al. 2010).

Urban and residential development has eliminated or greatly reduced some historic populations; the possibly extirpated population in Washington County, Utah, may have been lost to past agricultural and residential development in the St. George region (NatureServe 2026). Invasive plant species, particularly nonnative annual grasses, pose an indirect habitat threat by altering fire regimes in desert habitats and by competing with native species. Drought and the cumulative effects of climate change on gypsum soil habitats are additional potential stressors identified during Clark County Desert Conservation Program surveys (Ironwood Consulting 2020, 2021, 2023).

Threats to Species

Known or perceived threats to silverleaf sunray in Clark County include disturbance from off-highway vehicle use off designated routes, recreational activities, invasive weeds, drought, wild burro trampling, and cattle grazing (NatureServe 2026, Ironwood Consulting 2020, 2021, 2023). Large, attractive flower heads may be picked from plants growing near common gathering places, and some herbivory of flower heads and trampling by non-native ungulates has been observed in Lake Mead National Recreation Area (Bangle et al. 2010).

The species' narrow distribution within a limited geographic area and its strong affinity for specialized gypsum and sandy substrates make it particularly vulnerable to localized impacts. Although much of the species' range lies on federally managed lands that provide some level of protection, suitable habitat extends onto non-federal lands and into areas subject to covered activities under the MSHCP Amendment (SWECO 2018). The overall severity of threats and the species' capacity to respond to them are not well characterized (NatureServe 2026).

Conservation and Management

The majority of silverleaf sunray occurrences are located on federally managed lands that afford some degree of conservation benefit. Lake Mead National Recreation Area, administered by the NPS, contains the largest concentration of documented occurrences. NPS management policies direct managers to survey for, protect, and manage state- and locally listed species and other native species of special concern through maintenance of their natural distribution and abundance (NPS 2002, Bangle et al. 2010). Gold Butte National Monument and adjacent BLM lands provide additional habitat under federal management.

Management recommendations developed during past inventory work include closing access to illegal roads that traverse silverleaf sunray habitat, maintaining or enhancing patrols on BLM lands to limit off-highway vehicle activity off designated routes, and continuing monitoring efforts to better characterize environmental parameters that define the species' restricted range (Bangle et al. 2010). Coordination with Lake Mead National Recreation Area to minimize impacts from road maintenance, trespass livestock, and non-native ungulates also supports species conservation.

Based on habitat suitability modeling by Nussear et al. (2024), suitable silverleaf sunray habitat within the MSHCP Amendment Plan Area totals approximately 279,161 acres. Of this, 13,611 acres (4.9 percent) occur within the MSHCP Amendment Impact Area. Approximately 149,564 acres (53.6 percent) of suitable habitat falls within lands managed for resource conservation, and 54,223 acres (19.4 percent) occur within the MSHCP Amendment Reserve System Additions. No suitable habitat occurs within the existing MSHCP Reserve System.

Silverleaf sunray (*Enceliopsis argophylla*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	279,161	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	13,611	4.9%
Suitable Habitat in Lands Managed for Resource Conservation	149,564	53.6%
Suitable Habitat in the existing MSHCP Reserve System	0	0.0%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	54,223	19.4%

*Nussear et al. 2024

Clark County Survey Data

Systematic inventory of silverleaf sunray in Clark County was undertaken by the NPS at Lake Mead National Recreation Area from 2008 through 2010 with Clark County MSHCP funding (Bangle et al. 2010). During 2009, surveyors visited 212 sites focused on Lake Mead National Recreation Area and its immediate vicinity, including extensive surveys along Northshore Road and Lakeshore Road in the park and on adjacent BLM lands at Sunrise Hills, Rainbow Gardens, and Lava Butte. Between 20,000 and 30,000 silverleaf sunray plants were newly documented at more than 200 sites along Northshore Road and Lakeshore Drive, with occupancy observed at least every few miles from approximately one mile south of the Valley of Fire turnoff through the northernmost mile of Lakeshore Road. The largest cluster of sites was identified in the Echo Wash and Bitter Springs areas of Lake Mead National Recreation Area. Smaller populations were documented on Gold Butte, at Kingman Wash, and in the Bonelli Bay and Temple Bar area. The largest populations were associated with gypsum soils bearing thick biotic crusts, often co-occurring with Las Vegas bearpoppy, although the species was also common on gypsic areas with thin or no biotic crusts. Based on survey results, the study recommended maintaining the species' BLM Sensitive Species designation and Nevada Natural Heritage Program Sensitive Species status, and recommended that the MSHCP designate silverleaf sunray a Watch Species with Low Priority (Bangle et al. 2010).

Occurrence data used in the initial habitat suitability model were restricted to federal lands within Lake Mead National Recreation Area and surrounding BLM lands, and potential suitable habitat extends into

non-federal lands that may be affected by covered activities (SWECO 2018). More recently, rare plant surveys conducted by Ironwood Consulting for the Clark County Desert Conservation Program from 2020 through 2023 documented a combined total of 17 new element occurrence records for silverleaf sunray in Clark County. In 2020, four occurrences totaling 259 individuals over 0.9 acres were documented at St. Thomas Point (Ironwood Consulting 2020). In 2021, nine occurrences totaling 1,494 individuals over 38.1 acres were documented at Gold Butte, Gold Butte West, Mud Wash, Echo Junction, Bitter Spring, and West Lake Mead (Ironwood Consulting 2021). In 2023, four additional occurrences totaling 614 individuals over 21.8 acres were documented at the Arrow Canyon, Bitter Springs North, Echo Hills North, and Lava survey areas; all 2023 records were new occurrence records (Ironwood Consulting 2023). Occurrence quality across survey years ranged from poor to excellent, and threats documented at surveyed occurrences included drought impacts, off-highway vehicle use off designated routes, invasive weeds, wild burro trampling, and cattle grazing.

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Pahrump Valley Buckwheat (*Eriogonum bifurcatum*)

Photo Credit: Stefanie Ferrazzano, Clark County

Photo Credit: Ironwood Consulting

Species Overview

Pahrump Valley buckwheat (*Eriogonum bifurcatum*) is a low-spreading winter annual in the buckwheat family (Polygonaceae) that forms a flat-topped crown that can be more than one meter across (Reveal 1971, Mozingo and Williams 1980). It is also known by the common name "forked buckwheat," and was first described by Reveal from a type collection made on low rolling hills approximately one mile east of the California–Nevada line along Nevada Highway 52 in Pahrump Valley, Nye County, Nevada (Reveal 1971, Beatley 1977). The species belongs to a complex of white-flowering annual *Eriogonum* centered in the southwest deserts, many of which exhibit narrow distribution ranges, and it has the most geographically restricted range of the MSHCP Amendment covered plant species. The species blooms from late May to late June. Germination is largely dependent on winter precipitation; Beatley (1967) determined that approximately 15 to 25 millimeters of precipitation is required to germinate winter annuals in the northern Mojave Desert. As a result, population size fluctuates greatly from year to year: very few or no plants may be present in a dry year and thousands may be counted in a wet year (NNHP 2001, TNC 2007). This boom-and-bust annual life history makes estimation of population trends inherently difficult and has prompted suggestions that seedbank assays may provide more reliable insights into population status than counts of emergent plants (Nussear and Simandle 2020).

Range

Pahrump Valley buckwheat has an extremely restricted global range and is known only from the California–Nevada border area in the Mesquite and Pahrump valleys in Nevada and Stewart Valley in California (Reveal 1971, Crampton et al. 2006). The border region spans Clark and Nye counties in Nevada and Inyo and San Bernardino counties in California. The elevational range for this species is narrow, between 2,297 and 2,800 feet (700 to 853 meters) (NNHP 2001). The global distribution is approximately 47 miles in length and seven miles at its widest (TNC 2007), and the overall extent of occurrence is approximately 680 square kilometers (NatureServe 2026). Earlier reports of the species from Las Vegas Valley (Reveal 1985) and from a floristic inventory of Nellis Air Force Base (Hazlett et al. 1997) are considered erroneous, and there is no conclusive documentation of the species as far east as the Las Vegas Valley (TNC 2007).

Within Nevada, there are 19 known extant occurrences in Clark and Nye counties, with most occurring within Nye County (NNHP 2001, NatureServe 2026). In California, there are 40 occurrences in Inyo and

San Bernardino counties (CDFW 2017), which together with the Nevada occurrences can be grouped into four population groups (TNC 2007). The earliest documented occurrences are two 1941 collections made at a dry well in Pahrump Valley (Abrams 14238 and Wolf 10614), cited in Reveal (1971) and compiled by Beatley (1977), which constitute the earliest herbarium records for the species. Beatley's (1977) survey of threatened plants of the Nevada Test Site and central-southern Nevada provided the first comprehensive inventory of the species' narrow distribution in western Pahrump Valley and southern Stewart Valley. In Clark County, the species occurs only in Mesquite Valley in and around the town of Sandy Valley in the southwest region of the County, immediately adjacent to the Nye County border (Reveal 1971, Crampton et al. 2006, TNC 2007). Pahrump Valley buckwheat has also been documented on BLM lands near the town of Sandy Valley on the edge of the Mesquite dry lake (Crampton et al. 2006).

Habitat Characteristics

Pahrump Valley buckwheat occurs in valley bottoms, dry playa margins, and adjacent shore terraces (Crampton et al. 2006) on barren heavy clays, silty hardpan soils, saline flats, and sandy hills (NNHP 2001). The species is also found on rolling hills, stabilized dunes, and alkaline flats around dry lake beds. Documented soils include saline clay and silt hardpan soils, and the species is characteristic of the areas around Mesquite Dry Lake and similar features in the region (NatureServe 2026). Plants occur within Chenopod Scrub communities, and common co-occurring species include shadscale (*Atriplex confertifolia*), desert holly (*Atriplex hymenelytra*), honey mesquite (*Prosopis glandulosa* var. *torreyana*), Torrey's seepweed (*Suaeda torreyana*), and hopsage (*Grayia spinosa*) (NatureServe 2026). In Clark County, the species is associated with shadscale scrub and mesquite (*Prosopis* spp.) communities (Mozingo and Williams 1980, Calflora 2017). Within Clark County, suitable habitat occurs primarily in Mojave Desert Scrub and Salt Desert Scrub ecosystems, with lesser amounts in Mesquite Acacia (Nussear and Simandle 2020).

Substrates on valley landforms occupied by Pahrump Valley buckwheat are typically saline, heavy clay or silty hardpan soils derived primarily from Quaternary alluvial deposits and alluvial flat materials, with the Rumpah clay and Besherm–Tanazza soil associations most commonly mapped at Nevada occurrences (TNC 2007). Sites may be barren with no woody vegetation, but the plant is usually absent from compacted hardpan areas where roots cannot penetrate (TNC 2007). Known occurrence locations average approximately 778 meters in elevation and are most prevalent on flats with no slope or aspect; where the species occurs on gently sloping ground, it is most common on southwest to northwest exposures, and it rarely occurs on slopes steeper than 14 degrees (TNC 2007). Niles et al. (1998), noted that habitat at the type locality in Pahrump Valley occurs on low rolling hills, and observed that the late winter rains of 1998 produced very large populations in more friable, expanded, and uplifted clay materials around playas, while plants were typically absent in more compacted, clayey, hardpan areas.

Habitat Suitability Model

Nussear et al. (2024) modeled habitat suitability for Pahrump Valley buckwheat in Clark County using an ensemble modeling approach that combined GAM, Generalized Boosted Model, RF, and MaxEnt algorithms. Both base models and models incorporating a vegetation layer were developed. The ensemble model performed well, with Area Under the Curve values near 1.0 and BI values of 0.95 (base ensemble) and 0.87 (vegetation-inclusive ensemble), indicating strong model discrimination (Nussear et al. 2024).

The top influential variables in the base models were average maximum temperature, extreme minimum temperature, and slope, with soil clay content also contributing substantially in several algorithms (Nussear et al. 2024). Percent silt made the lowest contributions across most models. When vegetation was added as a covariate, the RF model attributed approximately 12 percent importance to the vegetation layer, while the GBM model relied most heavily on slope, extreme minimum temperature, and vegetation (Nussear et al. 2024). Localities were most strongly associated with North American Warm Desert Scrub and Grassland vegetation (Nussear et al. 2024).

High-suitability habitat is predicted primarily along the Nevada–California border in the vicinity of the Pahrump and Mesquite valleys, with Clark County habitat concentrated in and around Sandy Valley (Nussear et al. 2024). The vegetation-inclusive ensemble model also predicts a small patch of suitable habitat near the Corn Creek area along the U.S. 95 corridor (Nussear et al. 2024) (Figure 25). The Clark County suitable habitat footprint derived from this model provides the basis for the acreage figures reported in the Conservation and Management section.

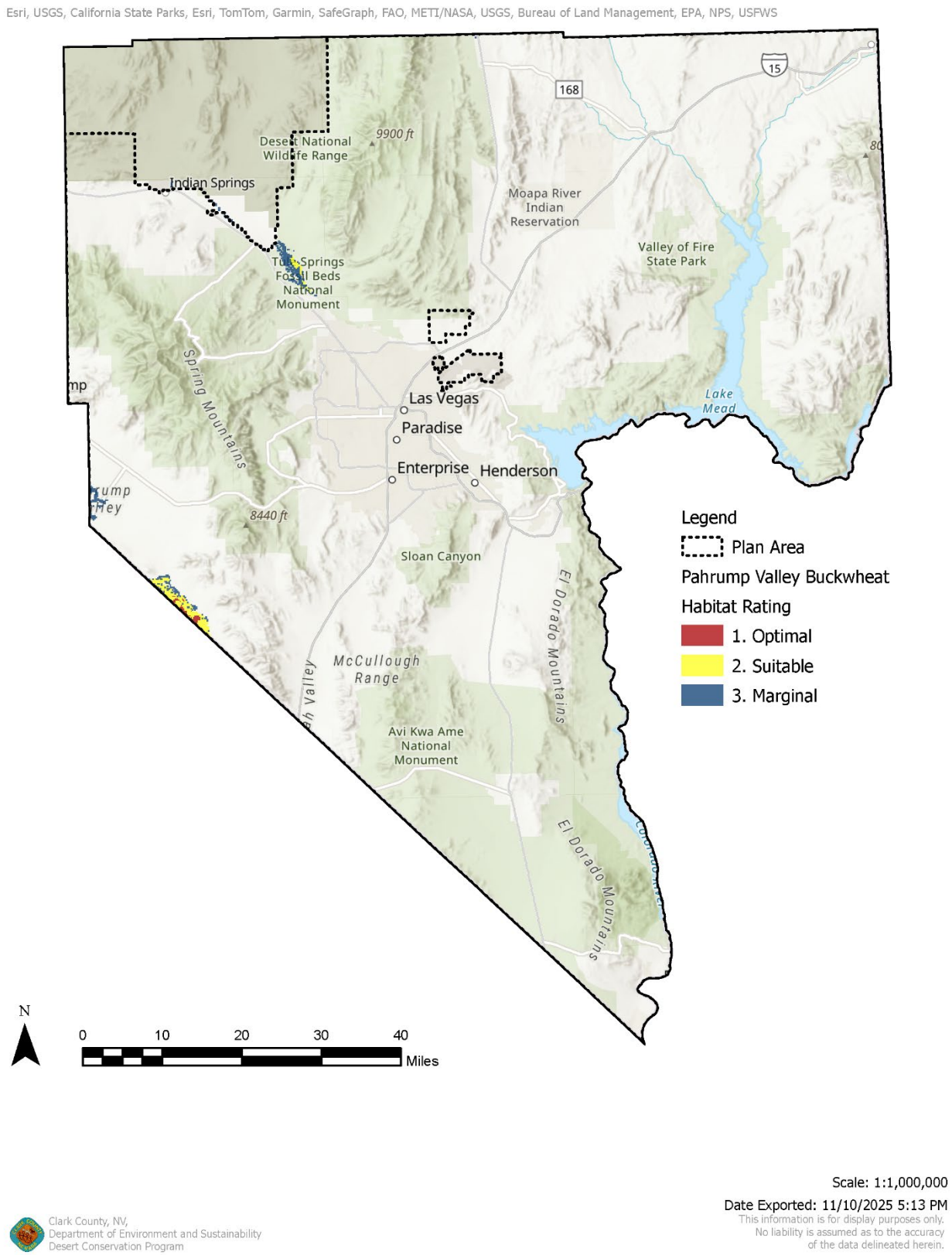

Figure 25. Habitat suitability model for Pahrump Valley buckwheat (*Eriogonum bifurcatum*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Covered
U.S. Fish and Wildlife Service Endangered Species Act	None*
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	None
California Native Plant Society	Rank 1B.2
NV Division of Natural Heritage	At Risk
NatureServe Global and NV State Rank	G3 S2
IUCN Red List	None
CITES	None

*Former USFWS Category 2 Candidate, defined as "[T]axa for which information now in the possession of the Service indicates that proposing to list as endangered or threatened is possibly appropriate, but for which persuasive data on biological vulnerability and threat are not currently available to support proposed rules" (USFWS 1993). The USFWS has revised its policy on Candidate Species and no longer includes this category.

The last ruling on the federal status of this species was published in the Federal Register on September 30, 1993, at which time it was determined that proposing forked buckwheat for listing may be appropriate, but that insufficient data on biological vulnerability and threats were available to support listing at that time (USFWS 1993). Pahrump Valley buckwheat is tracked by the Nevada Natural Heritage Program on its Animal and Plant At-risk Tracking List (NNHP 2025). NatureServe (2026) assigns the species a global rank of G3 (vulnerable) and a state rank of S2 in Nevada (imperiled), and S3 in California (vulnerable), reflecting its extremely restricted range and small number of known occurrences. The California Native Plant Society lists Pahrump Valley buckwheat as a Rank 1B.2 species, defined as rare, threatened, or endangered in California and elsewhere, and moderately threatened (CNPS 2017). The BLM in Nevada designates the species as Sensitive. No CITES or IUCN designations apply to this species. Although the species no longer has formal federal candidate status, its small range and ongoing threats mean it retains potential for future federal listing.

Population Trends

Germination and population expression in Pahrump Valley buckwheat are largely dependent on winter precipitation. As a result, population size fluctuates greatly from year to year: very few or no plants may be present in a dry year, while thousands may be counted in a wet year (NNHP 2001, TNC 2007). These fluctuations make estimation of long-term population trends inherently difficult, and NNHP (2001) characterized the population trend as unknown.

Despite the difficulty of quantifying trends, USFWS has described the range-wide status as declining based on recent occurrence records, and extirpations of populations have been reported on private lands near Sandy, Nevada (USFWS 2000, Nussear and Simandle 2020). Populations on public lands in

Pahrump and Stewart valleys have remained intact (Crampton et al. 2006). NatureServe (2026) characterizes the short-term trend as a decline of 10 to 30 percent, driven primarily by habitat conversion for urban development, although no extirpations have been documented in Nevada (Knight 1988, NatureServe 2026). In Nevada, the total number of individuals has been estimated at 1,109 or more, although this is acknowledged as an undercount given the species' annual life history and seedbank dynamics (Morefield 2001). Seedbank assays have been suggested as a method to better understand population status and viability independent of precipitation-driven fluctuations in adult plant expression (Nussear and Simandle 2020).

Historical range-wide population estimates provide context for the difficulty of interpreting trends in this annual species. Knight (1988), cited in TNC (2007), documented six populations globally, with two each in Stewart, Pahrump, and Mesquite valleys, each less than 2.5 acres (1 hectare) in extent, and estimated the total global population at approximately 10,000 plants. More detailed surveys were conducted by the BLM in 1998, a much above average precipitation year at the Pahrump climate station (8.49 inches compared with the long-term mean of 4.93 inches; WRCC 2004). Range-wide, the 1998 BLM surveys estimated approximately 12,550 to 25,677 plants across at least 1,630 acres in the Nevada Pahrump Valley, Stewart Valley, and Mesquite Valley population groups (TNC 2007). Because these numbers reflect a year of exceptionally favorable precipitation, they likely represent a best-case expression of the aboveground population rather than a stable baseline (TNC 2007).

Habitat Level Threats

Pahrump Valley buckwheat occurs in Salt Desert Scrub and Mesquite–Acacia ecosystems within Clark County. Threats to these habitats include commercial and residential development, land conversion for agriculture, off-highway vehicle use, unauthorized trail development, and dumping (Mozingo and Williams 1980, NNHP 2001, Nussear and Simandle 2020). USFWS (2009) identified additional habitat-level threats including a proposed airport, urban and industrial development, public land disposal, and utility corridors. Disturbance from these activities increases the risk of establishment and spread of invasive non-native plants and may alter surface- and groundwater flows that influence germination and persistence of this precipitation-dependent annual (TNC 2007). Although the species can tolerate moderate transient disturbance (NNHP 2001), the cumulative effects of habitat loss and hydrologic alteration across its narrow range represent the principal habitat-level concern.

Threats to Species

Direct threats to Pahrump Valley buckwheat include solar energy development, residential and commercial land development, off-road vehicle activity, and non-native invasive plants (CNPS 2017). The species has potential to occur on sites where large-scale solar projects have been proposed (Nussear and Simandle 2020). Although the species is described as tolerant of moderate transient disturbance (TNC 2007), utility corridors, trails, and off-road vehicles are indirect threats by facilitating invasive species establishment (TNC 2007). Annual precipitation is a major driver of year-to-year population variability, and changes to groundwater flow or hydrologic regimes may also affect this species (TNC 2007). TNC (2007) ranked rural development and sprawl, commercial development, groundwater development, highway and road construction and maintenance, and casual off-highway vehicle use and trail development as the highest-priority threats to Pahrump Valley buckwheat range-wide, with the Mesquite Valley population group in Clark County assigned very high overall threat status. Within Clark County, the single population near Sandy Valley occurs within BLM disposal boundaries, increasing

vulnerability to future land-use change (Ironwood Consulting 2023). Specific, species-level threats beyond these habitat-mediated pressures have not been identified (TNC 2007, USFWS 2009).

Conservation and Management

A conservation strategy specific to Pahrump Valley buckwheat was developed by The Nature Conservancy for the Clark County Desert Conservation Program. Recommended conservation actions include proactively protecting and managing for long-term viability of all populations on federal lands; ensuring that disposal of federal lands in Clark County does not significantly impact conservation of rare plant populations; ensuring that long-term viability of low-elevation rare plants is not significantly impacted by rural development and sprawl; investigating opportunities to acquire land or conservation easements for Pahrump Valley buckwheat habitats in Clark County; and designating two population groups for proactive protection (TNC 2007).

TNC (2007) emphasized that because Pahrump Valley buckwheat has the most limited global distribution of the nine low-elevation rare plants addressed in that strategy, any contribution Clark County can make to conservation management will benefit the long-term survival of the species. Recommended actions included enlarging federal land management through acquisition of occupied habitat in Mesquite Valley and coordinating with USFWS and Nye County partners on habitat conservation planning for the larger Nevada Pahrump and Stewart Valley population groups. TNC (2007) identified high-priority research and management needs for the species, including species extents and abundance surveys, reproductive biology, pollination ecology, population viability analysis, geospatial-based threats analysis, effectiveness and status monitoring, effects of fire and invasive plant interactions, effective restoration techniques, seed bank research, and an updated comprehensive conservation status report, noting that no monitoring activities and no restoration actions had been documented for the species at that time.

The USFWS Spotlight Species Action Plan for Pahrump Valley buckwheat (USFWS 2009) recommends acquiring precise acreage figures for occupied and potential habitats and developing a conservation strategy that avoids, minimizes, or mitigates loss of both occupied and potential habitat. Crampton et al. (2006) noted that conservation measures targeting mesquite woodlands in southern Nevada will provide indirect protection for Pahrump Valley buckwheat.

Based on habitat suitability modeling (Nussear et al. 2024), there are approximately 15,020 acres of suitable Pahrump Valley buckwheat habitat within the MSHCP Amendment Plan Area. Of this total, 5,301 acres (35.3 percent) occur within the MSHCP Amendment Impact Area, and approximately 4,574 acres (30.5 percent) occur within lands managed for resource conservation. No suitable habitat occurs within the existing MSHCP Reserve System. An additional 1,082 acres (7.2 percent) of suitable habitat are included within the MSHCP Amendment Reserve System Additions.

Pahrump Valley buckwheat (*Eriogonum bifurcatum*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	15,020	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	5,301	35.3%
Suitable Habitat in Lands Managed for Resource Conservation	4,574	30.5%
Suitable Habitat in the existing MSHCP Reserve System	0	0.0%

Pahrump Valley buckwheat (*Eriogonum bifurcatum*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Reserve System Additions	1,082	7.2%

*Source: Nussear et al. 2024.

Clark County Survey Data

Because Pahrump Valley buckwheat is an annual species highly dependent upon annual and winter precipitation, population size fluctuates substantially from year to year, making it difficult to assess long-term population trends from aboveground plant counts alone (NNHP 2001, TNC 2007). No seedbank studies have been conducted for this species in Clark County, although seedbank assessment has been suggested as a method to better understand population trends and viability independent of precipitation-driven fluctuations (Nussear and Simandle 2020).

Rare plant surveys conducted between April 2009 and May 2010 by ICF Jones & Stokes documented Pahrump Valley buckwheat at three locations across 511 survey plots distributed among 13 Geographic Units in Clark County, including 44 plots in the Sandy Valley Geographic Unit that encompasses the species' known range within the County (ICF Jones & Stokes 2010). Surveys employed teams of two botanists working 30-foot transects, with observations recorded both within survey plots and incidentally while traveling to and from plots. Pahrump Valley buckwheat was among the less frequently encountered of the ten target rare plant species surveyed (ICF Jones & Stokes 2010). Off-highway vehicle activity was commonly encountered across the survey effort, and the authors noted that open, lightly vegetated habitats with soft soils tend to be more vulnerable to off-highway vehicle disturbance (ICF Jones & Stokes 2010).

Rare plant surveys conducted in 2020 by Ironwood Consulting, Inc. documented Pahrump Valley buckwheat at the Pahrump, Sandy Valley, and Stateline PEAL survey areas. In total, these occurrences included 17,573 individuals occupying 12.79 acres (Ironwood Consulting 2020).

Subsequent surveys conducted in 2023 by Ironwood Consulting, Inc. documented four occurrences at the Near Sandy Valley and Rural ERBI survey areas, totaling approximately 246.8 acres (99.8 hectares) and an estimated 92,064 individuals. Three of the four occurrences were located within 0.5 mile of an existing record. The largest occurrence was at Near Sandy Valley (EO No. 5147), covering approximately 234.4 acres with an estimated 75,000 individuals. Common associated species included *Ambrosia dumosa*, *Atriplex confertifolia*, *Eriogonum trichopes*, and *Larrea tridentata*. Overall occurrence quality ranged from fair to good, with primary concerns including proximity to dusty unpaved roads, development pressure, and the location of both survey areas within BLM disposal boundaries (Ironwood Consulting 2023).

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Las Vegas Buckwheat (*Eriogonum corymbosum* var. *nilesii*)

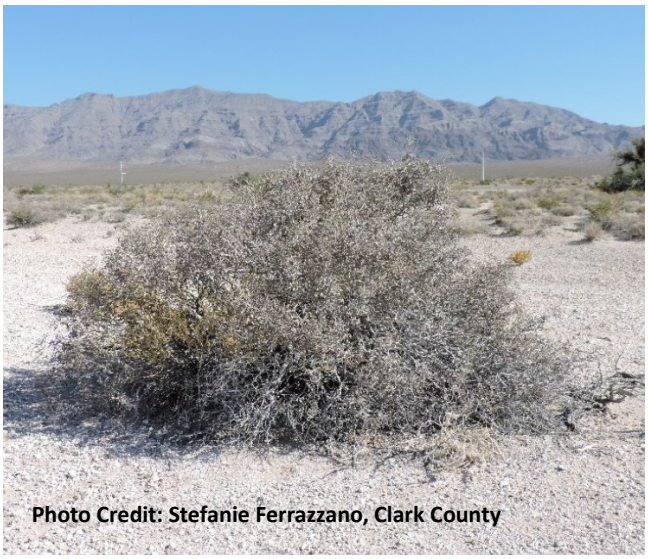

Photo Credit: Stefanie Ferrazzano, Clark County

Photo Credit: Stefanie Ferrazzano, Clark County

Species Overview

Las Vegas buckwheat (*Eriogonum corymbosum* var. *nilesii*) is a genetically distinct variety within the broadly distributed *Eriogonum corymbosum* complex, which comprises eight varieties (Reveal 2004, NatureServe 2026). It is a woody perennial shrub that may reach up to 4 feet in height, with numerous small yellow to pale yellow flowers that bloom from late August through November; the plant is particularly conspicuous during peak flowering in late September and early October. The variety is distinguished from closely related taxa by leaves that are densely hairy on one or both surfaces and at least twice as long as wide, with dense hairs spread along the stem (USFWS 2014b). Identification in the field can be difficult due to morphological similarity with closely related taxa, particularly *Eriogonum corymbosum* var. *aureum* (Ellis et al. 2018). Pollinators of Las Vegas buckwheat have not been technically identified; however, 20 invertebrate taxa have been observed visiting the flowers (Glenne 1999).

Range

Early examination of herbarium specimens suggested that Las Vegas buckwheat occurred in the Las Vegas Valley and potentially in two locations outside of Nevada: Paria River in southern Kane County, Utah; and Pierce Wash near St. George, Utah, in northern Mohave County, Arizona (Reveal 2004). Subsequent genetic investigations indicated that the Utah and Arizona locations are taxonomically distinct from those in southern Nevada (Ellis et al. 2009). The USFWS (2014a) later conducted additional investigations into putative populations across Utah, Arizona, and Nevada and concluded that, of 14 sampled locations, only four demonstrated strong genetic affinities to the reference location for *E. corymbosum* var. *nilesii*, and all four occur in southern Nevada. On the basis of morphological and genetic data, the recognized range of the variety is restricted to southern Nevada (USFWS 2014a). Plants in Arizona that approach var. *nilesii* are currently believed to be hybrids between var. *aureum* and var. *nilesii* (NatureServe 2026).

Within Nevada, Las Vegas buckwheat occurs in Clark and Lincoln Counties. In 2008, nine populations were known from 15 sites totaling approximately 1,145 acres across the two counties (Mrowka 2008). While somewhat widespread across Clark and Lincoln Counties, occupied habitat is limited, covering only

approximately 320 hectares (790 acres). Known populations occur in the Muddy Mountains of Lake Mead National Recreation Area, the north end of the Las Vegas Valley, Toquop Wash in Lincoln County, and in the north and south portions of Coyote Springs Valley in both Clark and Lincoln Counties. Some of the largest populations occur in the upper Las Vegas Wash ecosystem and on Nellis Air Force Base, with smaller populations in the Las Vegas Valley, Gold Butte, and the Muddy Mountains (Morefield 2007). Historically, the largest concentration of discrete localities has been in the Las Vegas Valley (USFWS 2008).

Habitat Characteristics

Las Vegas buckwheat is found on gypsum-based soils, clay beds, high-boron shale soils, and sparsely vegetated gypsum outcroppings in the Mojave Desert (Tilley 2012). Known populations occur between 200 and 850 meters (650 to 2,800 feet) in elevation in areas receiving an average of 110 millimeters (4.5 inches) of annual precipitation (Holmgren et al. 2012). The variety is strongly associated with soils with high gypsum content, clay beds, or high-boron content shales, and typically occurs with other gypsophilic species on sparsely vegetated sites with cryptogamic soil crusts (Meyer 1986, Drohan and Merkler 2009, USFWS 2014a).

Observations from inventories at Lake Mead National Recreation Area and adjacent BLM lands have described habitat conditions at a finer scale. Populations at Gold Butte have been documented on the Upperline–Weiser–Whitebasin, Boxspring–Zeheme–Rockoutcrop, Zeheme–Rockoutcrop, and Valatier–Goldbutte soil associations, with the largest occurrence recorded on the Upperline–Weiser–Whitebasin association (Newton et al. 2010). Although earlier treatments characterized habitat as occurring in washes, drainages, or areas of generally low relief (NNHP 2004), individuals have also been observed growing on steep, largely bare slopes at Gold Butte (Newton et al. 2010). Populations in this area occur at the higher end of the reported elevation range and are associated with blackbrush (*Coleogyne ramosissima*) communities. At Bill's Spring on Gold Butte, Las Vegas buckwheat was observed growing in a discrete patch of gypsic soil surrounded by granitic soils, with individuals at a flat area near the spring appreciably larger than those on adjacent steep, bare slopes; this size difference may reflect access to subsurface water at the location near the spring (Newton et al. 2010). Where the species occurs on gypsic substrates, it has been observed to avoid areas with thick biotic soil crust, even when individuals are growing immediately adjacent to such surfaces (Newton et al. 2010).

Habitat Suitability Model

Nussear et al. (2024) developed an updated ensemble habitat suitability model for Las Vegas buckwheat in Clark County. The base model ensemble was comprised of contributions from RF, GAM, MaxEnt, and GBM algorithms, while a separate vegetation-inclusion ensemble incorporated RF and GBM models. Both model configurations produced a similar footprint of predicted habitat. The base model performed well overall, with Area Under the Curve, BI, and TSS values all high and with minimal losses between training and testing data. The models including vegetation also performed strongly.

The top influential variables in the base model were coefficient of variation of winter precipitation and average maximum temperature, with soil gypsum content and Normalized Difference Vegetation Index amplitude also contributing. NDVI maximum contributed relatively little across all algorithms. In the vegetation-inclusion models, the vegetation layer contributed 25 percent in the GBM model and 14 percent in the RF model, while average maximum temperature and soil gypsum remained among the highest-performing variables for both. The vegetation associated with Las Vegas buckwheat localities

was largely attributed to Land Use and Development, with secondary attribution to North American Warm Desert Scrub and Grassland and Western North American Cool Semi-Desert Scrub and Grassland (Nussear et al. 2024).

High-suitability habitat is predicted to occur in urban Las Vegas and south of Coyote Springs, with pockets of medium-suitability habitat east of the Las Vegas Valley, in the Muddy Mountains, and west of the Weiser Valley, Indian Springs Valley, Three Lakes Valley, and the northwestern end of the Las Vegas Valley (Nussear et al. 2024). The habitat suitability model for Las Vegas buckwheat is shown in Figure 26.

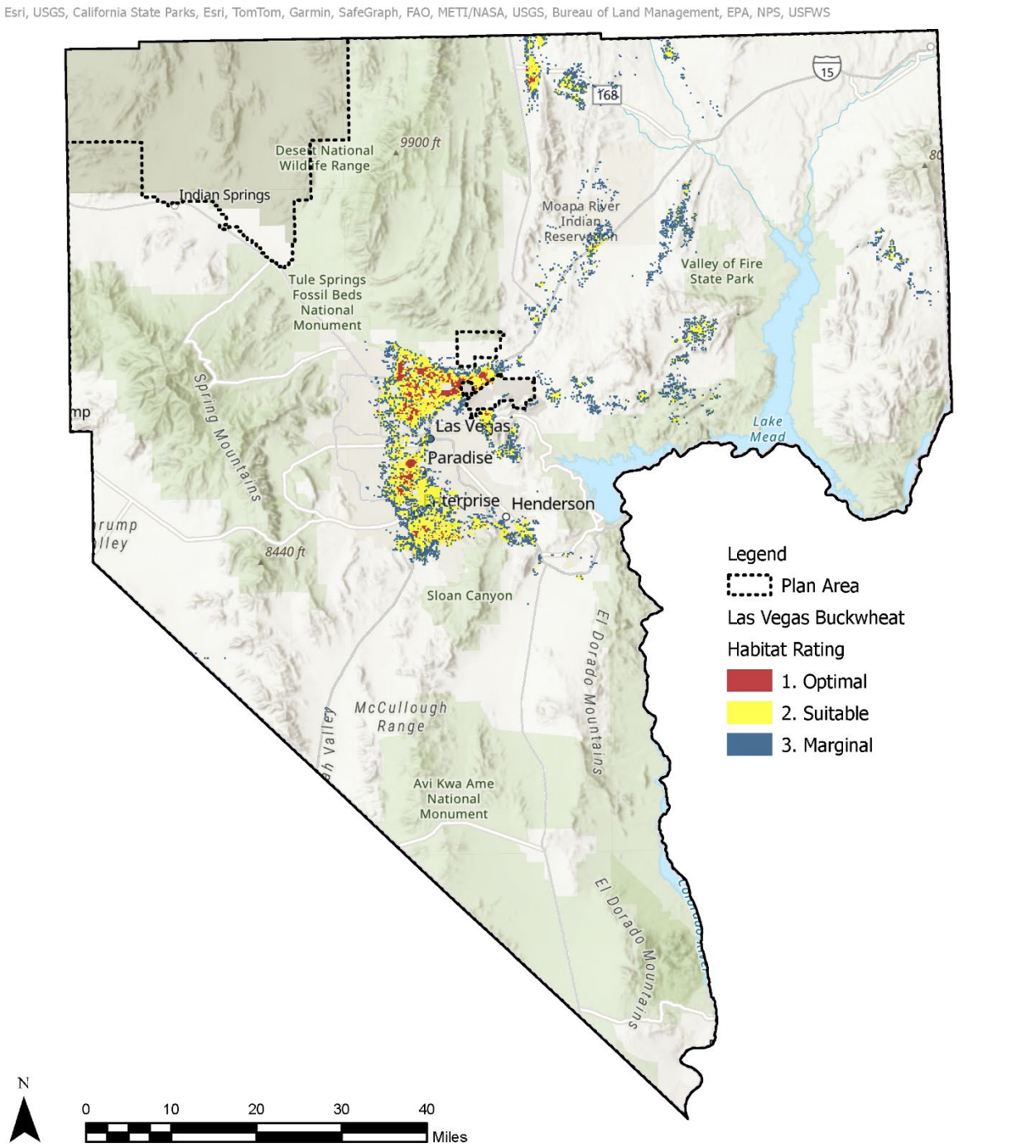

Figure 26. Habitat suitability model for Las Vegas buckwheat (*Eriogonum corymbosum* var. *nilesii*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Evaluation*
U.S. Fish and Wildlife Service Endangered Species Act	None
U.S. Bureau of Land Management (Nevada; BLM 2023)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	None
NV Division of Natural Heritage	At Risk
NV Climate Change Vulnerability Index	Not Addressed
NatureServe Global and NV State Rank	G5T2 S2
IUCN Red List (v 2025-2)	None
CITES	None

* Listed under the former name *E. c.* var. *aureum*.

A petition to list Las Vegas buckwheat for Federal Endangered Species Act protection was filed on April 22, 2008 (Mrowka 2008). In the 90-day and 12-month findings, the USFWS determined that the petition was substantial and that listing of the species as threatened or endangered was warranted but precluded by other, higher priority actions (USFWS 2008). The species remained in that status until September 24, 2014, when a new finding determined that listing was not warranted (USFWS 2014b). No new petitions for listing have been submitted since that time.

NatureServe (2026) currently ranks Las Vegas buckwheat as globally imperiled (G5T2), imperiled at the national level (N2), and imperiled in Nevada (S2). The primary threats driving these rankings are urban development, off-road vehicle use, and gypsum surface mining, with NatureServe noting that approximately 95 percent of the variety's habitat has already been developed (NatureServe 2026). NatureServe estimates 6 to 20 element occurrences globally, occupying a range extent of approximately 5,000 to 20,000 square kilometers. The variety has no CITES or IUCN Red List designation.

Population Trends

Interpretation of population trend data for Las Vegas buckwheat requires caution due to several factors: inconsistent use of terms such as site, location, subpopulation, and population across source materials; variation in census and estimation methods applied by different groups; and error associated with delineating polygons to define stand boundaries. These factors render the available data too variable to support formal demographic analysis (USFWS 2014a).

A broader spatial analysis was provided by USFWS (2014a). Of the 12 populations originally recognized, three have been extirpated by urban development and highway construction, and impacts to two of the nine remaining extant populations are considered imminent. Las Vegas buckwheat is known to have been extirpated from approximately 527 hectares (1,305 acres), representing a loss of nearly 62 percent of its range (USFWS 2014a). Most lands from which the variety has been extirpated are in private ownership (94.9 percent); the remainder are owned or managed by the City of Las Vegas (1.95 percent),

Clark County (2.24 percent), or the Department of Defense (0.9 percent). NatureServe (2026) similarly reports a long-term decline of 50 to 70 percent and a short-term decline of 30 to 50 percent, noting that 3 of 12 previously recognized occurrences have been lost and 4 of the extant locations have been partially extirpated.

Habitat Level Threats

Las Vegas buckwheat occupies Mojave Desert Scrub and Salt Desert Scrub ecosystem types, frequently on a subset of soils that also support other sparsely vegetated plant communities. Urbanization and infrastructure development, including utility corridors and highways, are the primary habitat-level threats to the variety (Mrowka 2008, USFWS 2009). Additional identified threats include off-highway vehicle use (including dirt bikes), illegal dumping, transient migrant habitation, flood control development, plant invasions, recreational activities (equestrian use and pedestrian traffic), and surface mining and mineral claims, particularly for gypsum (Edwards 2007, USFWS 2009, BLM 2011, USFWS 2014a). Non-native plant species of concern include *Halogeton glomeratus*, *Salsola tragus*, and *Strigosella africana* (synonym *Malcolmia africana*, African mustard).

Fire dependent on non-native invasive grasses has also been identified as a potential threat (USFWS 2014a). However, the most prevalent invasive grasses in the region (*Bromus madritensis* var. *rubens* and *Schismus* spp.) do not thrive on gypsum soils and therefore do not typically provide sufficient fuel to support fire in most cases. Climate change is considered a possible threat, although the extent of its effects is not yet well understood (USFWS 2010).

Site-specific habitat-level threats have been documented at individual populations. At Gold Butte, one Las Vegas buckwheat population was observed immediately adjacent to a recently burned area that had been colonized by cheatgrass, elevating the risk of subsequent fire in otherwise occupied habitat, and another population was observed to be bisected by an illegal off-highway vehicle route, resulting in soil compaction and the potential for direct mortality of individuals (Newton et al. 2010). Gold Butte populations near springs were also observed to show signs of cattle use, indicating potential risks of herbivory, trampling, and localized alteration of hydrology at these sites (Newton et al. 2010).

Threats to Species

Past, ongoing, and future threats to Las Vegas buckwheat include urban development, off-highway vehicle use, mineral exploration and development, invasive plants, and climate change (Mrowka 2008, USFWS 2014a). Urbanization, utility and transportation corridor development, and off-highway vehicle activity can cause wholesale losses of Las Vegas buckwheat populations. Other disturbance sources, such as dumping and recreation, can damage or kill individual plants in addition to degrading habitat. Several remaining populations are at risk due to land ownership patterns and the potential for future urban development. Las Vegas buckwheat is not adapted to fire and is very slow growing, rendering it particularly vulnerable to any fire events that do occur (USFWS 2010).

Conservation and Management

Several conservation measures have been implemented that benefit Las Vegas buckwheat (USFWS 2009, 2014a). These include a conservation agreement between the City of North Las Vegas and the BLM to establish the Eglington Preserve; fencing installed by BLM to protect the Eglington Preserve and limit unauthorized off-highway vehicle impacts; fencing installed by Nellis Air Force Base to protect habitat within Nellis Area III; BLM purchase of 30 acres of the White Basin subpopulation; BLM withdrawal of

public minerals within portions of Las Vegas buckwheat habitat; designation of the Muddy Mountains Wilderness; and establishment of the Tropicana and Decatur Buckwheat Conservation Area. Additionally, during restoration efforts at Las Vegas Springs Preserve, several Las Vegas buckwheat plants were planted at the site; although these plantings do not meaningfully contribute to overall population size, they serve as a public education feature highlighting the variety.

Based on modeled habitat suitability (Nussear et al. 2024), the MSHCP Amendment Plan Area contains approximately 148,814 acres of suitable Las Vegas buckwheat habitat. Of this total, approximately 12,661 acres (8.5 percent) occur within the MSHCP Amendment Impact Area. Approximately 24,805 acres (16.7 percent) of suitable habitat occur within lands managed for resource conservation, and 12,527 acres (8.4 percent) occur within the MSHCP Amendment Reserve System Additions. No suitable habitat is mapped within the existing MSHCP Reserve System.

Las Vegas buckwheat (*Eriogonum corymbosum* var. *nilesii*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	148,814	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	12,661	8.5%
Suitable Habitat in Lands Managed for Resource Conservation	24,805	16.7%
Suitable Habitat in the existing MSHCP Reserve System	0	0.0%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	12,527	8.4%

*Source: Nussear et al. 2024

Clark County Survey Data

Inventories completed between 2008 and 2010 by the NPS at Lake Mead National Recreation Area and adjacent BLM lands documented Las Vegas buckwheat at multiple sites in eastern Clark County. Surveys recorded occurrences in the Muddy Mountains near Lovell Wash and at several locations on Gold Butte, including a subpopulation near Bill's Spring. Over the course of this effort, one previously undocumented subpopulation was identified and the mapped extent of an existing Gold Butte population was expanded (Newton et al. 2010). The largest occurrence recorded during these inventories was in the Muddy Mountains Wilderness near Lovell Wash, where the population occupied greater habitat heterogeneity than observed elsewhere, with a dense core on a flat area of thin soil crust and additional individuals scattered across surrounding hills and washes (Newton et al. 2010).

Rare plant inventories conducted by ICF Jones & Stokes for the Clark County Desert Conservation Program between April 2009 and May 2010 surveyed 511 standardized four-hectare (approximately ten-acre) plots across 13 geographic units in Clark County for ten target rare plant species, including Las Vegas buckwheat (ICF Jones & Stokes 2010). Across the full survey effort, Las Vegas buckwheat was recorded at three locations: two within designated survey plots and one as an incidental observation made while traveling to or from a survey plot (ICF Jones & Stokes 2010). These results are consistent with the variety's comparatively narrow and patchy distribution in Clark County relative to other rare plants with broader habitat affinities.

Rare plant surveys conducted in Clark County in 2021 identified a single, inconclusive occurrence of Las Vegas buckwheat at one location in Gold Butte (Ironwood 2021). The occurrence was estimated to

include 232 individuals occupying approximately 1.7 acres (0.6 hectares) between 740 and 746 meters (2,428 to 2,448 feet) elevation, with associates including *Ambrosia salsola*, *Ephedra torreyana*, *Hilaria rigida*, *Krameria* sp., *Psorothamnus fremontii*, and *Yucca brevifolia* (Ironwood 2021). The overall quality of the occurrence was rated as excellent, although minor off-highway vehicle disturbance was noted adjacent to the occupied habitat (Ironwood 2021). The identification was inconclusive due to morphological similarity between Las Vegas buckwheat and *Eriogonum corymbosum* var. *aureum* and the poor condition of the focal specimen, with drought conditions during fieldwork contributing to the lack of vigor and diagnostic morphological features needed for confident identification (Ellis et al. 2018, Ironwood 2021). Ironwood (2021) recommended revisiting this occurrence under improved conditions to verify the identity of the plants and collecting voucher specimens for deposit in a regional herbarium to support review by taxonomic experts and to provide additional material for ongoing genetic and morphological research. Subsequent rare plant surveys in 2023 targeted suitable habitat within Clark County but did not encounter Las Vegas buckwheat at any of the surveyed locations (Ironwood 2023). Future surveys specifically targeting this variety are recommended, with a focus on gypsiferous soils in the Las Vegas area and areas to the northeast, including Gold Butte National Monument and Mesquite (Ironwood 2023).

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Sticky Buckwheat (*Eriogonum viscidulum*)

Photo Credit: Ironwood Consulting

Photo Credit: Ironwood Consulting

Species Overview

Sticky buckwheat (*Eriogonum viscidulum*) was originally described by Howell (1942) from Clark County, Nevada. It is a member of the buckwheat family (Polygonaceae) and is an herbaceous winter annual with a life span of approximately five to eight months from seed germination to seed dissemination and death (Beatley 1974, 1976). Plants grow up to 40 centimeters tall, with diffusely branched stems arising from a basal rosette of leaves. Small yellow flowers bloom in April and May, and plants are best surveyed between April and June (Morefield 2001). The species is most readily distinguished from related annual *Eriogonum* species by the viscid, glandular hairs that cover its stems and branches, which give the plant a sticky texture and often cause adhering sand particles to cover the plant surface (NNHP 2001). The species was first collected by Alice Eastwood and J.T. Howell at the Riverside Bridge on the Virgin River in Clark County, Nevada (Howell 1942; Bangle et al. 2010). The specific epithet *viscidulum* is the diminutive form of *viscida* and references the sticky globules of brown, viscid liquid produced at the tips of stem hairs (TNC 2007). Sticky buckwheat is closely related to *Eriogonum subreniforme* of southern Utah, northern Arizona, and northwestern New Mexico, but is distinguished from that species by its yellow flowers and the viscid surface near the base of the plant (Reveal 1978; Bangle et al. 2010).

Sticky buckwheat is a facultative winter annual whose seeds disperse in spring (May to June) with primary dormancy and require one to three months of warm, dry after-ripening before they can germinate. Seeds are capable of germinating across a broad temperature range (greater than or equal to 10 degrees Celsius to less than or equal to 25 degrees Celsius), allowing emergence during autumn and winter months. Seeds buried in habitat germinated almost completely following sufficient cool, wet conditions, indicating a nondormant state during autumn. The species maintains a persistent soil seed bank, and seed bank propagation in greenhouse or nursery settings has been demonstrated as a viable method for ex situ conservation seed collection during drought years when plants are absent from habitat. Mating system studies showed that sticky buckwheat is self-compatible, though invertebrate pollinators (particularly Bombyliidae flies) are present and may contribute to genetic diversity in natural populations (DeFalco et al. 2023).

Range

Sticky buckwheat is endemic to the eastern Mojave Desert and is known only from Clark and Lincoln counties, Nevada, and Mohave County, Arizona (NatureServe 2026; DeFalco et al. 2023). The global range extent is estimated at 1,000 to 5,000 square kilometers (approximately 400 to 2,000 square miles), with an estimated area of occupancy of approximately 53 two-kilometer by two-kilometer grid cells based on herbarium specimens, photo-based observations, and NatureServe Network occurrence data collected between 1993 and 2024 (NatureServe 2026).

Clark County, Nevada represents the majority of the species' global distribution (TNC 2007). All known occurrences have been organized into 13 population groups centered on the confluence of the Muddy and Virgin Rivers and extending south along Lake Mead (TNC 2007; DeFalco et al. 2023). In Nevada, the maximum range dimension is approximately 75.5 kilometers (46.9 miles), excluding the most disjunct record (NNHP 2001). Occurrences are documented across lands administered by the BLM, the NPS (primarily within Lake Mead National Recreation Area), the Bureau of Reclamation, and on private and state lands (NNHP 2001; DeFalco et al. 2023).

Habitat Characteristics

Sticky buckwheat is restricted to deep, loose sandy soils, a habitat that is widespread within its range but narrowly defined in character (NatureServe 2026). The species grows in washes, flats, roadsides, steep aeolian slopes, and stabilized dune areas at elevations ranging from approximately 350 to 750 meters (1,200 to 2,200 feet) (Morefield 2001; NNHP 2001). It is dependent on sand dunes or deep sand in Nevada and can withstand moderate temporary disturbance (Morefield 2001).

Associated species in sandy habitats include *Ambrosia dumosa* (white bursage), *Larrea tridentata* (creosote bush), *Pleuraphis rigida* (big galleta), *Krameria parvifolia* (littleleaf ratany), *Achnatherum hymenoides* (Indian ricegrass), *Astragalus geyeri* var. *triquetrus* (threecorner milkvetch), *Astragalus sabulonum* (gravel milkvetch), *Eriogonum trichopes* (little deserttrumpet), *Ephedra torreyana* (Torrey's jointfir), *Dicoria canescens* (desert twinbugs), *Croton californicus* (California croton), *Sporobolus cryptandrus* (sand dropseed), and *Psorothamnus fremontii* (Fremont indigo bush) (NNHP 2001). Sticky buckwheat habitat includes dune formations, open beach sand at waterline and on adjacent sandy slopes, solidified sands of dry wash channels, and sandy soils within matrix creosote bush ecological systems (TNC 2007).

The species' distribution is strongly associated with the Muddy Creek Formation, a sedimentary deposit that is widely exposed in the hills along the Overton Arm, Virgin Basin, and Boulder Basin sections of Lake Mead National Recreation Area and that extends northward along the Virgin River valley and westward along the Muddy River and Meadow Valley Wash. Weathered sediments from this formation, re-deposited as aeolian or fluvial sand, provide the substrate on which sticky buckwheat is found (Niles et al. 1995; Bangle et al. 2010). The majority of mapped occurrences are on Triassic tufaceous sedimentary rocks, with some on alluvial deposits, and the species most commonly maps on Badland and Toquop fine sand soil associations; sands supporting sticky buckwheat are delivered to its habitat primarily by fluvial transport (TNC 2007). Occurrences range from 366 to 767 meters (1,200 to 2,515 feet) in elevation and occur on slopes averaging about 8 degrees but occasionally as steep as 53 degrees, with west and east exposures the most common (TNC 2007).

Habitat Suitability Model

Nussear et al. (2024) developed an ensemble habitat suitability model for sticky buckwheat using generalized additive model, generalized boosted model, RF, and Maxent algorithms. Two modeling configurations were produced: a base model and a model that additionally incorporated a vegetation layer. The base ensemble model was composed of 20 RF, 7 GAM, 3 Maxent, and 10 GBM models, while the vegetation-inclusive ensemble was composed of 20 RF and 17 GBM models. Model performance was high for both configurations, with Area Under the Curve values of 1.00 and TSS values of 1.00 for the base ensemble when evaluated against all points. The BI values were strong for the base ensemble (0.94 across all data) but weaker for testing data in the GAM and GBM algorithms and for the vegetation-inclusive models (Nussear et al. 2024).

Among the environmental covariates tested, coefficient of variation of winter precipitation and average spring maximum temperature had generally high contributions across the algorithms. The Maxent model was largely dependent on CV of winter precipitation (95.7 percent importance), while the GBM model was largely dependent on average spring maximum temperature (82.2 percent importance). The GAM and RF models were more balanced in their variable contributions, drawing on average spring maximum temperature (47.8 percent and 48.0 percent, respectively), CV of winter precipitation (32.2 percent and 23.3 percent), depth to bedrock, coarse fragments, and sand content. In the vegetation-inclusive models, the vegetation layer itself contributed moderately to the RF model (7.6 percent) but was not used by the GBM model. Sticky buckwheat localities were most commonly associated with North American Warm Desert Scrub and Grassland and Western North American Cool Semi-Desert Scrub and Grassland vegetation types (Nussear et al. 2024).

Predicted high-suitability habitat is concentrated in and around the confluence of the Muddy and Virgin rivers and extends into the Muddy Mountains and adjacent sandy habitats in eastern Clark County. The vegetation-inclusive model more closely associated high-suitability habitat with the Muddy and Virgin River areas than the base model. The habitat suitability model for sticky buckwheat is shown in Figure 27.

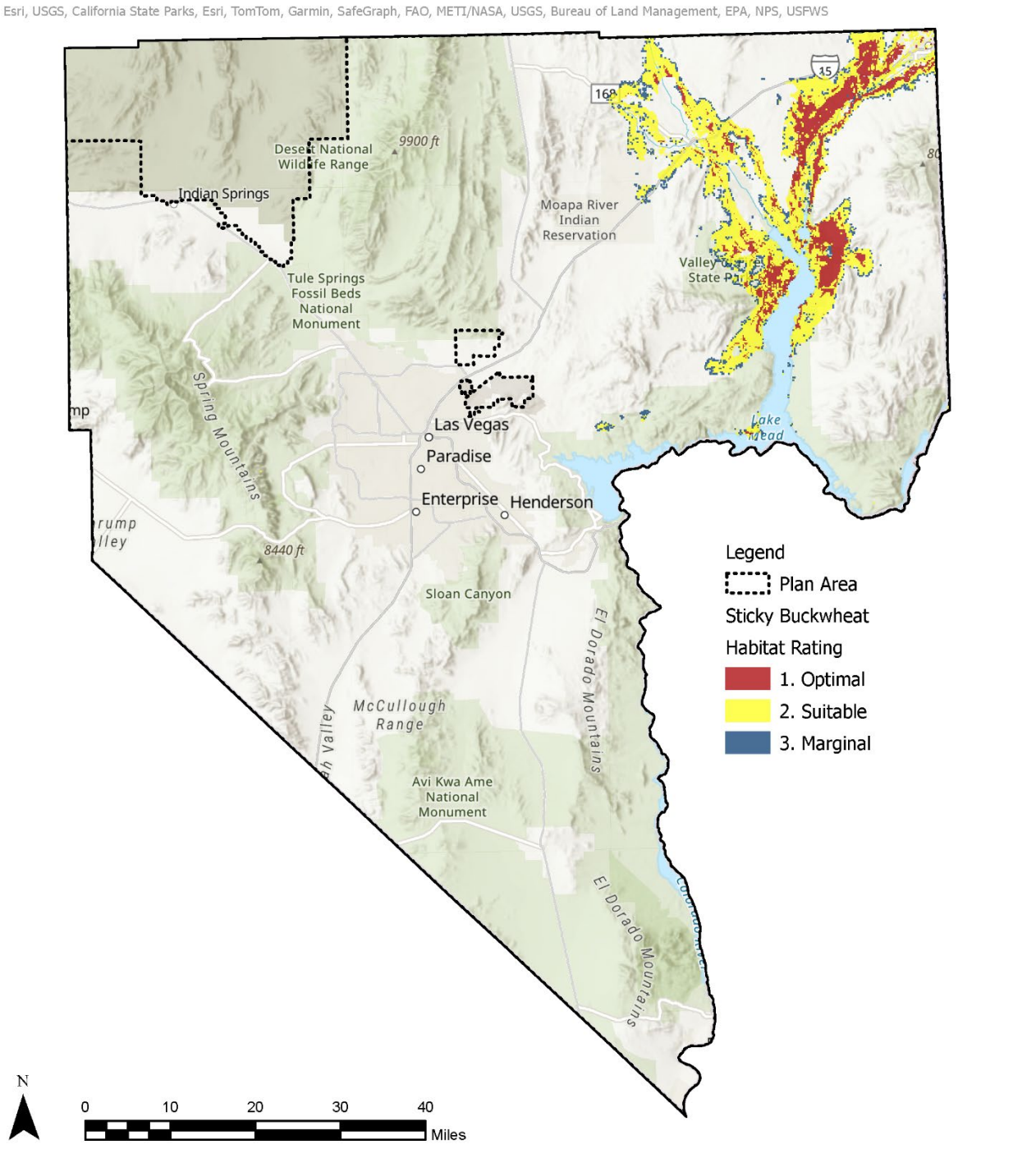

Figure 27. Habitat suitability model for sticky buckwheat (*Eriogonum viscidulum*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Covered
U.S. Fish and Wildlife Service Endangered Species Act	None*
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	Critically Endangered Plant - Fully Protected
State of Arizona	Special-status Species
NV Division of Natural Heritage	At Risk
NV Climate Change Vulnerability Index	Not Addressed
NatureServe Global and NV State Rank	G2? S1S2
IUCN Red List	None
CITES	None

*Former USFWS Category 2 Candidate, defined as "[T]axa for which information now in the possession of the Service indicates that proposing to list as endangered or threatened is possibly appropriate, but for which persuasive data on biological vulnerability and threat are not currently available to support proposed rules." (USFWS 1993). The USFWS has revised its policy on Candidate Species and no longer includes this category.

Sticky buckwheat holds a NatureServe Global Status of G2 (Imperiled), last reviewed on April 22, 2024. The species is ranked N2? nationally and holds state ranks of S2 (Imperiled) in Nevada and S1 (Critically Imperiled) in Arizona (NatureServe 2026). It is not currently listed under the Endangered Species Act, though it remains a species of concern for the USFWS (NatureServe 2026). The Nevada Natural Heritage Program classifies it as Sensitive and the State of Nevada lists it as a Fully Protected, Critically Endangered plant. It is also a BLM Special Status Species in Nevada (NNHP 2001). The species is not currently listed under the IUCN Red List or CITES.

Population Trends

Population trend data for sticky buckwheat are limited, in part because the species' annual life history makes it highly sensitive to interannual precipitation variability, which can cause populations to appear or disappear entirely from year to year (Morefield 2001; NatureServe 2026). Germination is heavily influenced by annual precipitation, resulting in fluctuations in population size and number of occurrences from year to year (NatureServe 2026).

Earlier status reports indicated unknown trends (Reveal 1978; USFWS 2000; Morefield 2001). As of 2001, sticky buckwheat populations were estimated to comprise approximately 25,000 individuals in 29 mapped occurrences throughout Nevada, with an unknown habitat extent (Morefield 2001). TNC (2007) estimated the sticky buckwheat's viability across four grouped areas over its range as "fair." Monitoring was initiated at Lake Mead National Recreation Area in 2003 (Powell 2003), but annual fluctuations from variable climate conditions have obscured population trends. Surveys by Niles et al. (1995) documented approximately 20,020 individuals across 22 locations, with the Upper Muddy River population group supporting the highest density at an estimated 7,128 plants, and Lime Wash and Black Mountains also ranking among the population groups with the highest recorded numbers of individuals (Bangle et al. 2010). The Lime Wash habitat that supported an estimated 13,500 individuals in 1995 was subsequently inundated in 1998 as Lake Mead water levels rose, eliminating much of that occupied habitat (TNC 2007).

As reservoir levels have declined in more recent years, sticky buckwheat has re-occupied portions of its former habitat, although invasive species including Sahara mustard and tamarisk are also rapidly occupying these newly exposed lakeshore sites (TNC 2007).

NatureServe estimates approximately 45 occurrences range-wide based on a 1-kilometer separation distance applied to herbarium, photo-based, and NatureServe Network occurrence data from 1993 to 2024, with eight occurrences rated very good to good viability and seven rated fair to poor (NatureServe 2026). The long-term trend is characterized as a decline of less than 50 percent to relatively stable, and the short-term trend remains unknown due to interannual fluctuations driven by variable precipitation (NatureServe 2026). Seed bank studies by DeFalco et al. (2023) detected viable seeds in soils collected from historic points at Toquop Wash in 2021, even though adult plants were absent during scouting, indicating that a persistent seed bank may sustain populations through drought years. However, samples collected around senescing plants at Black Mountain did not always produce seedlings during the soil seed bank grow-out, and seed densities were generally low across all populations studied, including those with plants present at the time of collection (DeFalco et al. 2023).

Habitat Level Threats

The degree of threat to sticky buckwheat habitat is rated High by NatureServe (2026). Habitat-level threats include habitat destruction from recreational activities such as trail construction and maintenance; off-highway vehicle use; burro and livestock trampling and grazing; mineral and gravel extraction; utility corridor construction and maintenance; and the spread of non-native plant species. About ten occurrences fall within the active Mormon Mesa grazing allotment, and another nine fall within Gold Butte National Monument, where unregulated cattle grazing has occurred for more than a decade (NatureServe 2026). Several sand and gravel mines exist within occupied habitat along the Virgin River and around Mesquite. The occupied habitat is transected by Interstate 15, state highways, county roads, railroads, overhead power lines, and buried pipelines (RECON 2000; Hiatt and Boone 2003; NatureServe 2026). Large-scale solar energy developments have been proposed for Mormon Mesa and other occupied habitats but have not been approved (NatureServe 2026).

Historically, the largest loss of sticky buckwheat was likely due to inundation by Lake Mead (Niles et al. 1995; Powell 1999). Occurrences within Lake Mead National Recreation Area are afforded some protection, though some are still affected by lake level fluctuations and recreational pressures (NatureServe 2026).

Invasive non-native plant species documented in sticky buckwheat habitat include *Tamarix ramosissima* (saltcedar), *Salsola tragus* (tumbleweed/Russian thistle), *Brassica tournefortii* (Sahara mustard), *Bromus rubens* (red brome), and *Schismus* spp. (Mediterranean grass) (RECON 2000; DeFalco et al. 2023; NatureServe 2026). These invasive species compete with sticky buckwheat for resources, alter fire regimes, and modify sandy habitat conditions. High-intensity storms can also cause significant erosion in the sandy habitat of sticky buckwheat (Yurkanin et al. 2014). TNC (2007) assessed threats to sticky buckwheat populations and ranked seven as High: rural development and sprawl, increased fire frequency and intensity, energy development, invasive plant species, casual off-highway vehicle use and trail development, surface water development, and agricultural practices. Exotic annual species, particularly red brome and Mediterranean grass, can carry fire through the typically sparsely vegetated sandy habitats and elevate the risk of type conversion in the matrix creosote bush communities on which sticky buckwheat depends (TNC 2007). Sticky buckwheat requires open spaces and loose soils; in areas heavily invaded by Sahara mustard, Mediterranean grass, saltcedar, and Russian thistle, the species is typically

absent, suggesting that invasive cover can exclude the species from otherwise suitable habitat (Bangle et al. 2010).

Threats to Species

Beyond the habitat-level threats described above, sticky buckwheat is directly threatened by climate-driven changes in precipitation regimes. Increased drought intensity may reduce the germination and growth of sticky buckwheat seeds, though the species' capacity to produce large seed crops in favorable years provides some resilience to climate-driven precipitation variability (Cuello et al. 2022). However, significant precipitation occurring outside of normal seasonal patterns may cause seeds to germinate outside of the normal growing season, leading to low survival and reproductive success (NatureServe 2026). The current megadrought gripping the southwestern United States has brought reduced and more variable cool-season rainfall to the region, with longer dry periods documented across the Desert Southwest (Williams et al. 2022; Zhang et al. 2021; DeFalco et al. 2023).

Trespass cattle and competition with invasive annual species have been documented as direct threats to sticky buckwheat populations in monitoring reports from Lake Mead National Recreation Area (Bangle 2012). Because of the species' narrow distribution and the coincidence of its habitat with areas of intense development pressure in southern Nevada, inappropriate livestock grazing and trampling, non-native plant and animal species, and off-road vehicle use have impacted the habitat over the long term (RECON 2000; NatureServe 2026).

Conservation and Management

Sticky buckwheat is a covered species under the Lower Colorado River Multi-Species Conservation Plan, and the goal for the species in that plan area is to maintain and increase populations (Bangle 2012). Portions of the species' range occur within Lake Mead National Recreation Area, where occurrences receive some protection from federal management, although they are still subject to lake-level fluctuations and recreational impacts (NatureServe 2026). TNC (2007) developed a conservation management strategy for nine low-elevation rare plants in Clark County, Nevada, which includes sticky buckwheat and identifies habitat protection, monitoring, and research priorities across the 13 recognized population groups.

Seed ecology research conducted by DeFalco et al. (2023) has provided a practical framework for ex situ conservation of the species. The authors demonstrated that seed bank propagation in greenhouse or nursery settings is a viable means to make conservation seed collections, particularly at historic sites where a viable seed bank may persist but where recent surveys have found no plants. They recommend that soils be collected after seed dispersal (July to September) and stored under prevailing summer temperatures to allow after-ripening before autumn watering to trigger germination. Seeds collected directly from adult plants require warm, dry conditions for after-ripening and can remain nondormant under cold storage (5 degrees Celsius) (DeFalco et al. 2023). Continued inventory for additional populations is needed, particularly on federal lands, since this annual plant does not grow every year (NNHP 2001; NatureServe 2026).

Based on habitat suitability modeling by Nussear et al. (2024), approximately 257,366 acres of suitable habitat for sticky buckwheat occur within the MSHCP Amendment Plan Area. Of this, 20,797 acres (8.1 percent) occur within the MSHCP Amendment Impact Area. Approximately 117,390 acres (45.6 percent) of suitable habitat fall within lands managed for resource conservation, and 607 acres (0.2 percent) occur within the existing MSHCP Reserve System. An additional 9,128 acres (3.5

percent) of suitable habitat are located within MSHCP Amendment Reserve System Additions.

Sticky buckwheat (*Eriogonum viscidulum*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	257,366	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	20,797	8.1%
Suitable Habitat in Lands Managed for Resource Conservation	117,390	45.6%
Suitable Habitat in the existing MSHCP Reserve System	607	0.2%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	9,128	3.5%

*Source: Nussear et al. 2024.

Clark County Survey Data

Systematic surveys for sticky buckwheat in Nevada have been extensive but remain incomplete (NNHP 2001). The Nevada Natural Heritage Program reported, as of 2001, a total of 29 occurrences mapped at 1.0-kilometer separation (or 37 occurrences at 0.16-kilometer separation), with estimated total individuals exceeding 25,000. Average year of last survey at that time was 1989, and approximately 54 percent of mapped records had been surveyed within the preceding six to ten years (NNHP 2001).

Surveys by Niles et al. (1995) in Lake Mead National Recreation Area and adjacent regions of Nevada and Arizona documented the occurrence and distribution of sticky buckwheat and recorded Black Mountain and Lime Wash as two of the population groups with the highest numbers of individuals. Monitoring of sticky buckwheat within Lake Mead National Recreation Area was initiated by Powell (1999, 2003) and continued under the Lower Colorado River Multi-Species Conservation Program, which documented large interannual variation in abundance characteristic of winter annual species (Bangle 2012).

Systematic rare plant surveys were conducted by ICF Jones & Stokes on behalf of the Desert Conservation Program between April 2009 and May 2010 at 511 four-hectare survey plots distributed across 13 Geographic Units in Clark County, with sticky buckwheat as one of 10 target species. Sticky buckwheat was located five times during those surveys: four observations within survey plots and one incidental observation recorded while traveling to or from a plot (ICF Jones & Stokes 2010).

Intensive site-level monitoring of sticky buckwheat was conducted at Lake Mead National Recreation Area in 2008 and 2009 at Lime Cove and Glory Hole (Bangle et al. 2010). Sticky buckwheat numbers increased across the two monitoring years at both sites. Shrub cover was significantly higher at Glory Hole than at Lime Cove, and native and non-native cover were approximately equal at Lime Cove, while non-native cover was at least three times greater than native cover at Glory Hole. Sticky buckwheat presence was positively related to native cover at Lime Cove and negatively related to non-native cover at Glory Hole, where saltcedar and Russian thistle were the dominant non-native cover and appeared to be occupying open spaces and using resources otherwise available to sticky buckwheat (Bangle et al. 2010). Reconnaissance surveys conducted in 2008 documented approximately 100 to 150 plants along Overton Beach Road and 50 to 100 plants near Ebony Cove in the Black Mountains area of Lake Mead National Recreation Area, and confirmed continued presence at Middle Point, Klein Hole, and Virgin River Dunes, although no new populations were discovered (Bangle et al. 2010).

Seed ecology fieldwork conducted by the USGS between 2020 and 2023 focused on four population groups: Toquop Wash and Upper Muddy River on BLM lands, and Black Mountain and Lime Wash on NPS lands within Lake Mead National Recreation Area. Scouting during the prolonged regional drought found

plants to be rare in 2020 and absent in 2021 and 2022 at most locations, consistent with the species' sensitivity to cool-season rainfall (DeFalco et al. 2023).

Rare plant surveys conducted by Ironwood Consulting on behalf of the Clark County Desert Conservation Program have provided the most current occurrence data for the species within Clark County. Surveys in 2020 detected new occurrences in Halfway Wash and South Mormon Mesa survey areas. These occurrences were good to excellent in quality and comprised a total of 271 individuals across 1.1 acres, at elevations ranging from 562 to 616 meters (Ironwood 2020). Despite targeting suitable habitat in 2021, sticky buckwheat was not detected, an absence attributed to two consecutive years of below-average annual precipitation (approximately 2.4 inches in 2020 and 1.9 inches in 2021, compared to the 30-year average of 4.2 inches), which suppressed germination of annual plants across the survey areas (Ironwood 2021). Surveys in 2023 detected occurrences in East Mormon 2, West Mormon 2, and West Mormon 3 survey areas, with a total of 1,733 individuals across 4.5 acres at elevations ranging from 456 to 550 meters and ranging from fair to good in quality (Ironwood 2023).

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White-margined Beardtongue (*Penstemon albomarginatus*)

Species Overview

White-margined beardtongue (*Penstemon albomarginatus*) is a low-growing perennial herb in the family Plantaginaceae, with pallid foliage and a deep, woody taproot measuring approximately 1 to 4 feet in length. The species is distinguished by its spatula-shaped leaves and calyx lobes that are conspicuously white-margined, which give the plant its common name. Flowers are pink-lavender with darker purple accents and typically bloom from March through May (NNHP 2001). Mature plants produce capsular fruits that split lengthwise to release numerous small seeds (DeFalco et al. 2023).

The species is a psammophile, meaning it is restricted to sandy habitats, and requires permanent, non-shifting sand of sufficient depth to permit the establishment and maintenance of its deep root system (Scogin 1989). Recent research has clarified important aspects of the species' reproductive biology. White-margined beardtongue is an obligate outcrosser, requiring cross-pollination for fruit set, and therefore depends on maintenance of pollinator populations for successful reproduction (DeFalco et al. 2023). Documented flower visitors include small bees in the genera *Ashmeadiella*, *Anthidium*, and *Lasioglossum* (DeFalco et al. 2023). Seeds exhibit non-deep physiological dormancy with seasonal dormancy cycling, and successful germination requires warm summer after-ripening followed by cool, moist autumn and winter conditions (DeFalco et al. 2023). Recruitment is rare and episodic, tied to successive wet years that favor seed production, germination, and seedling establishment (Etyemezian et al. 2010; DeFalco et al. 2023).

Mature plants produce up to 15 shoots forming a cluster approximately one foot in diameter (TNC 2007). After seed dispersal in June, plants wither to a brown mat that becomes difficult to identify by winter, although established plants resprout annually (TNC 2007). Flowering does not appear to be strongly dependent on current-year rainfall, except in extreme years, as the deep taproot is thought to provide stored water and food reserves that support reproduction in drier years (MacKay 1998, as cited in TNC 2007). Demographic monitoring by Andre at the Pisgah site in California (Lavic Lake population group) between 1991 and 2000 found an average individual lifespan of 3.3 years and a maximum of 7 years, with older plants disproportionately important to overall fecundity: 16 percent of plants contributed 78

percent of seed production, and herbivory was the primary cause of mortality (Andre, personal communication to Smith 2001, as cited in TNC 2007).

Range

The global distribution of white-margined beardtongue is restricted to the southeastern Mojave Desert ecoregion and spans three states. The species is known from four widely disjunct population centers: Pisgah Crater in San Bernardino County, California; Jean and Roach Valleys in Clark County, Nevada; Amargosa Valley in Nye County, Nevada; and Dutch Flat in Mohave County, Arizona (NatureServe 2026). Southern Clark County appears to be the center of the species' distribution, with three arms radiating northwest into Nye County, southwest into California, and southeast into Arizona (TNC 2007).

In Nevada, white-margined beardtongue occurs in Clark and Nye counties, with elevations ranging from approximately 2,750 to 5,890 feet (838 to 1,795 meters) (NNHP 2001). The distribution in Clark County is limited to its southern portion and comprises four population groups that are mostly separated by hill topography disconnecting the valley bottoms. These Clark County populations are located approximately 48 kilometers southwest of Las Vegas near Jean, Nevada, and occur within 20 kilometers of one another: Ivanpah Valley, Hidden Valley, Roach Lake, and Jean Lake (DeFalco et al. 2023). Because southern Clark County is centrally located within the species' limited global extent, maintaining these core populations and their habitat is important for providing connectivity and for the species' long-term survival (TNC 2007).

Habitat Characteristics

White-margined beardtongue occupies sandy habitats with mostly deep, loose to stabilized sand, sometimes on stabilized sand dunes or in sandy to gravelly washes. In Nevada, plants occur on loose deposits of aeolian sand or sandy alluvium, particularly in or near small dry drainages, wash bottoms, on valley floors, gentle foot-slopes, or alluvial terraces (Smith 2001). The species is typically found in openings with shrub cover below 20 percent, at the base of hills and mountains in wind-blown areas, and in loose sand washes (NatureServe 2026; Etyemezian et al. 2010). This specialized habitat is embedded within the zonal creosote bush to white bursage or salt desert scrub ecological systems in Clark County.

Geospatial analysis of known point locations across the species range indicates an average elevation of 909 meters (range 363 to 1,057 meters, or 1,190 to 3,467 feet) (TNC 2007). The species shows a marked preference for gentle slopes averaging about three degrees, although plants may occur on slopes up to 29 degrees, and warmer western exposures (northwest to southwest) are more common than cooler east, southeast, northeast, or north exposures (TNC 2007). Prevailing western winds are thought to deposit seeds on windward slopes, and the sandy substrate appears to hold sufficient moisture for the species to persist on warmer exposures during its growing months (TNC 2007). In Nevada, occupied habitat tends to occur on the lee side of valleys and on lower foothill slopes of western mountain flanks, with sand sources upwind at sparsely vegetated valley bottoms and barren playas such as the Amargosa Valley, Ivanpah Valley, and Jean Lake (TNC 2007). White-margined beardtongue consistently occurs on mapped Quaternary alluvial deposits, and the most commonly mapped soil associations at known locations include Prisonear fine sand, BluePoint-Grapevine, and BluePoint associations (TNC 2007).

Field studies in Clark and Nye counties have quantified the species' habitat requirements in detail. Etyemezian et al. (2010) found that *P. albomarginatus* habitat is characterized by soils with greater than 80 percent sand to a depth of at least 60 centimeters, slopes of 1.8 to 4.6 percent, south-to-west

aspects, and shrub cover below 20 percent. The Bluepoint and Arizo soil series supported the largest populations in both counties. Plant community analysis identified the native perennial grass *Pleuraphis rigida* and the native shrubs *Krascheninnikovia lanata* and *Acamptopappus shockleyi* as the most likely indicator species in Clark County, with 66 to 94 percent of plants occurring in canopy inter-spaces (Etyemezian et al. 2010). Although present-day aeolian sand transport rates at occupied sites are very low, the aeolian origin of the soils is considered a key habitat attribute (Etyemezian et al. 2010).

Habitat Suitability Model

Nussear et al. (2024) developed an ensemble habitat suitability model for white-margined beardtongue in Clark County using RF, GAM, MaxEnt, and GBM algorithms. The base model was built using depth to bedrock, clay content, extreme minimum temperature, slope, winter precipitation, and coefficient of variation of winter precipitation as predictor variables. A second model incorporated a vegetation layer in addition to these base variables. The base model demonstrated high performance across all algorithms, with high values and minimal losses between training and testing data for Area Under the Curve, BI, and TSS measures (Nussear et al. 2024).

The top influential variables in the base model were winter precipitation, CV of winter precipitation, and depth to bedrock, which had generally high contributions across algorithms. In the models incorporating vegetation, depth to bedrock, CV of winter precipitation, and sand content were the most influential, while vegetation itself had only low to moderate influence. Model localities were predominantly associated with North American Warm Desert Scrub and Grassland and Western North American Cool Semi-Desert Scrub and Grassland vegetation types (Nussear et al. 2024).

The base model and the vegetation-enhanced model differed considerably in their predictions. The vegetation-enhanced model produced a more restrictive predicted habitat area, with suitable habitat concentrated along the Interstate 15 corridor in concordance with known localities and reduced predicted area around the perimeter of Las Vegas (Figure 28; Nussear et al. 2024).

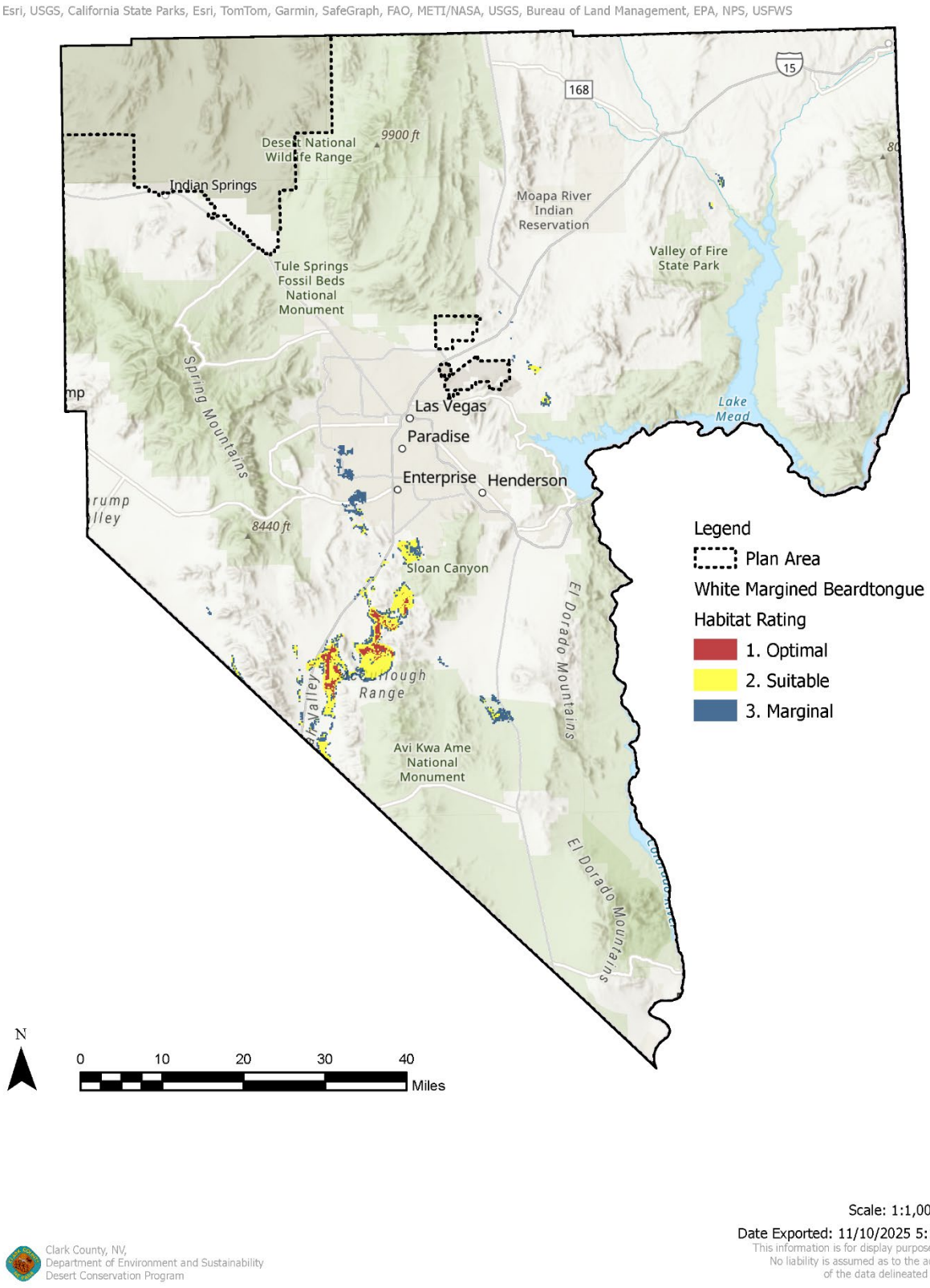

Figure 28. Habitat suitability model for white-margined beardtongue (*Penstemon albomarginatus*) in Clark County, Nevada (Nussear et al. 2024).

Species Status

Agency/Organization	Status
MSHCP (2000)	Covered
U.S. Fish and Wildlife Service Endangered Species Act	Under Review*
U.S. Bureau of Land Management (Nevada)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	None
California Rare Plant Society	Rank 1B.1
State of Arizona	Salvage Restricted
NV Division of Natural Heritage	At Risk
NV Climate Change Vulnerability Index	Not Addressed
NatureServe Global and NV State Rank	G1 S2
IUCN Red List	None
CITES	None

* Former USFWS Category 2 Candidate, defined as "[T]axa for which information now in the possession of the Service indicates that proposing to list as endangered or threatened is possibly appropriate, but for which persuasive data on biological vulnerability and threat are not currently available to support proposed rules" (USFWS 1993). The USFWS has revised its policy on Candidate Species and no longer includes this category.

Under the U.S. Endangered Species Act, white-margined beardtongue is currently Under Review following a 90-day finding by USFWS on January 25, 2024, that a petition to list the species may be warranted. The species is included in the USFWS FY24 to FY28 National Domestic Listing Workplan (USFWS 2024; NatureServe 2026). The petition was submitted by the Center for Biological Diversity in March 2023, seeking listing as threatened or endangered and concurrent designation of critical habitat (NatureServe 2026). In the 90-day finding, USFWS determined that the petition presented substantial scientific or commercial information indicating that listing may be warranted based on habitat loss and degradation due to land development and off-highway vehicle use (Factor A) and the effects of climate change (Factor E) (USFWS 2024). The petition also presented information suggesting that cattle grazing (Factor A), insect and mammalian predation (Factor C), invasive plant species (Factor E), and pollinator limitation (Factor E) may be threats to the species; USFWS will fully evaluate these additional potential threats during the 12-month status review (USFWS 2024).

White-margined beardtongue is recognized as a species of significant conservation concern across its entire range. NatureServe (2026) assigns the species a global rank of G1 (Critically Imperiled), with a national rank of N1 in the United States. State ranks are S1 (Critically Imperiled) in California, S1S2 in Arizona, and S2 (Imperiled) in Nevada. The Nevada Natural Heritage Program (2001) previously assigned ranks of G2 S2 and listed the species as Threatened under the Nevada Native Plant Society. The species is a BLM Special Status Species in Nevada, Salvage Restricted in Arizona, and is ranked 1B.1 (rare,

threatened, or endangered in California and elsewhere; seriously threatened in California) by the California Rare Plant Society. The species is not listed under CITES or the IUCN Red List.

Population Trends

Population trends for white-margined beardtongue are sharply negative. NatureServe (2026) characterizes the long-term trend as a decline of 70 to 80 percent range-wide. Early survey data were limited; the Nevada Natural Heritage Program (2001) estimated more than 14,000 individuals in Nevada across 13 to 16 occurrences, covering approximately 368 hectares. Subsequent surveys by Smith (2001) estimated 25,964 plants in Clark County and 42,200 in Nye County. A resurvey by Etyemezian et al. (2010) substantially revised these figures upward, estimating approximately 125,825 plants in Clark County and 78,954 in Nye County, roughly five times and two times the Smith (2001) estimates, respectively. The authors note, however, that methodological differences between the two survey approaches make it unclear whether the discrepancy reflects a genuine population increase (Etyemezian et al. 2010).

Peak abundance across all populations was documented at 309,199 plants during surveys conducted between 1988 and 2010. The most recent comprehensive surveys in 2021 found only 68,535 plants across all four populations, a dramatic reduction from the peak estimate (NatureServe 2026; Miller 2021). Documented declines from historical estimates to the most recent surveys are as follows: Mohave County, Arizona, 99.8 percent; San Bernardino County, California, 99.0 percent; Clark County, Nevada, 73.2 percent; and Nye County, Nevada, 56.2 percent (NatureServe 2026). NatureServe (2026) notes that no occurrences have been evaluated as having Very Good or Good estimated viability; 19 occurrences have been evaluated as having only Fair or Poor viability.

The species has low rates of reproduction and recruitment, and because it is an obligate outcrosser, fruit production is significantly reduced without access to pollinators, further limiting its capacity for recovery (DeFalco et al. 2023). Recruitment events are rare and episodic, tied to successive wet years that favor seed production, germination, and seedling survival (Etyemezian et al. 2010; DeFalco et al. 2023).

Habitat Level Threats

TNC (2007) considers the overall threat status for white-margined beardtongue populations as very high. Populations of white-margined beardtongue have been reduced in size and extent by direct mortality of individuals and loss or fragmentation of habitat. The primary habitat-level threats to the species in Clark County are rural development, mineral exploration, utility corridor construction and maintenance, highway and road construction and maintenance, legal and illegal off-highway vehicle events, federal land disposal to private ownership, sand and gravel mining, and construction of the planned Ivanpah Airport (TNC 2007).

Utility-scale solar energy developments near the California and both Nevada populations would introduce additional ground disturbance. Highways, surface roads, railroads, and utility corridors cross all populations, and stormwater management for these roads causes surface water flow disruptions in some areas (NatureServe 2026).

The historic prevalence of cattle grazing in combination with the introduction and spread of highly flammable exotic annuals has played a substantial role in altering historic fire regimes within the creosote bush-dominated landscape. Recent fires in the Mojave Desert indicate the likelihood of more frequent fire as weeds increase in cover and native shrubs decrease (TNC 2007).

Threats to Species

Direct threats to individual plants and populations of white-margined beardtongue include climate change and drought, invasive plant species, off-highway vehicle use, natural herbivory, and livestock grazing.

Off-highway vehicle use is present in all populations and is most prevalent in the California and Clark County, Nevada, populations. Numerous organized off-road races occur within occupied habitat in both Nevada populations (NatureServe 2026). Direct impacts of off-highway vehicle recreation on the species have been documented through pre- and post-race monitoring conducted by the BLM at a sanctioned race pit in the Jean Lake population in 1996 (BLM unpublished data, as reported in TNC 2007). Post-race monitoring that year recorded 19.7 percent fewer and 16.3 percent smaller average-diameter plants relative to pre-race conditions, with approximately 41.8 percent of plants classified as damaged to severely damaged and 46 percent dead or dying; only 21 percent of plants remained in pre-race condition (TNC 2007). In 1997 and 1998, following relocation of the race pit, average plant diameters were 16 and 48 percent larger than pre-race baselines, respectively, suggesting that white-margined beardtongue can recover in the absence of continued off-highway vehicle traffic under favorable growing conditions (TNC 2007).

Livestock grazing occurs in the Arizona and Clark County populations, although the impact from grazing has not been quantified (NatureServe 2026).

The increasing frequency and intensity of droughts is causing substantial declines in all populations; plants produce fewer flowers and viable seeds during drought years and may remain completely dormant during severe events (Miller 2021; NatureServe 2026).

Invasive plants, including Sahara mustard (*Brassica tournefortii*), Mediterranean grass (*Schismus* spp.), and tumbleweed (*Salsola tragus*), are present in all populations, particularly along roads, utility corridors, and other disturbed areas (NatureServe 2026). The annual invasive *Schismus* sp. was encountered across all known occurrences within the Jean Dry Lake survey area during rare plant surveys (Ironwood Consulting 2020).

Natural herbivory is present across all populations, with rabbits and insects as the most prominent herbivores. Large blister beetles (*Epicauta puncticaulis*) have been observed consuming flowers in the California population, which may affect pollination and seed production (NatureServe 2026).

Because white-margined beardtongue is an obligate outcrosser, any threat that reduces pollinator abundance or activity also represents an indirect threat to the species' reproductive success (DeFalco et al. 2023). Pollinator observations at the Pisgah site in California by Scogin (1989, as cited in TNC 2007) identified a vespid wasp as a likely effective pollinator and documented visits by carabid beetles and large flies, while a large blister beetle was observed devouring leaves and is considered a significant herbivore.

Conservation and Management

A portion of white-margined beardtongue habitat in Arizona has been designated as the White-Margined Penstemon Reserve Area of Critical Environmental Concern. Portions of the habitat in California are protected within Mojave Trails National Monument, the Pisgah Research Natural Area

ACEC, and under National Conservation Land status (NatureServe 2026). The species is also a BLM Special Status Species in Nevada, which provides some management consideration on federal lands.

Existing regulatory mechanisms provide partial but incomplete protection for white-margined beardtongue across its range. In Nevada, the species is included on the Nevada Natural Heritage Program At-Risk Plant and Animal Tracking List, but this designation is informational rather than protective (USFWS 2023). In Arizona, the species is protected under the 2016 Arizona Native Plant Law, which requires developers to obtain a permit before removing plants from the wild but does not prevent habitat loss from private or public land development (USFWS 2023). In California, the species is ranked 1B.1 by the California Rare Plant Society, which obligates agencies to analyze effects to the species when conducting environmental review under the California Environmental Quality Act; however, threats from unauthorized off-highway vehicle use and climate change are not subject to analysis under CEQA (USFWS 2023). Areas of occupied habitat in California are also addressed under the California Desert Renewable Energy and Conservation Plan, as part of the Mojave Trails National Monument, and within the Pisgah Research Natural Area ACEC, although these protections do not directly address unauthorized off-highway vehicle use or climate change (USFWS 2023). BLM lists white-margined beardtongue as a sensitive species in Arizona, California, and Nevada, and must consider effects to sensitive species in National Environmental Policy Act documents when evaluating a proposed action; if significant environmental effects are predicted, the agency must propose mitigations that could offset those effects, but BLM is not obligated to choose alternatives with less effect to the species and its habitat (USFWS 2023). Within the Arizona ACEC, private landowners are not prevented from developing their land (USFWS 2023).

The BLM manages the majority of white-margined beardtongue habitat within Clark County, including the Hidden Valley, Jean Lake, and Roach Lake population groups in their entirety and approximately 80 percent of the Ivanpah Valley population group (TNC 2007). Two BLM exclosures were established to protect occupied habitat from livestock grazing and off-highway vehicle disturbance: a 50-acre exclosure in the Hidden Valley population group and a 30-acre exclosure in the easternmost portion of the Jean Lake population group. Demographic data have been collected inside and outside both exclosures annually since 1998, except during the extreme drought year of 2002 when plants were virtually absent (TNC 2007). Management recommendations developed for Hidden Valley by Sheldon (1994, as cited in TNC 2007) included fencing approximately 470 acres to protect most of the population from cattle grazing, limiting vehicle travel to existing roads and trails, constructing an exclosure to monitor grazing effects, conducting additional searches at Jean and Roach dry lakes, and developing a tri-state conservation agreement among the California, Nevada, and Arizona BLM District offices for range-wide protection.

Research conducted through the Clark County Desert Conservation Program has identified management implications for the species. Because of the species' deep root system, transplanting is not a practical mitigation tool; however, seed-based establishment at suitable sites may be feasible, and soils collected from occupied habitat can be used for propagation when appropriate warm after-ripening and cold incubation conditions are met (Etyemezian et al. 2010; DeFalco et al. 2023). DeFalco et al. (2023) recommend periodic seed testing during long-term storage of conservation collections because of the species' physiological dormancy. Maintenance of pollinator populations is also essential for reproduction in wild populations given the species' obligate outcrossing mating system (DeFalco et al. 2023).

Based on habitat suitability modeling (Nussear et al. 2024), approximately 56,178 acres of suitable habitat for white-margined beardtongue occur within the MSHCP Amendment Plan Area. Of this total, 17,364 acres (30.9 percent) fall within the MSHCP Amendment Impact Area. Approximately 11,118 acres (19.8 percent) of suitable habitat occur within lands managed for resource conservation, and 201 acres (0.4 percent) occur within the existing MSHCP Reserve System. An additional 6,876 acres (12.2 percent) of suitable habitat are within the MSHCP Amendment Reserve System Additions.

White-margined beardtongue (*Penstemon albomarginatus*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	56,178	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	17,364	30.9 percent
Suitable Habitat in Lands Managed for Resource Conservation	11,118	19.8 percent
Suitable Habitat in the existing MSHCP Reserve System	201	0.4 percent
Suitable Habitat in the MSHCP Amendment Reserve System Additions	6,876	12.2 percent

*Source: Nussear et al. 2024.

Clark County Survey Data

Early surveys of white-margined beardtongue in Clark County, including those compiled by the Nevada Natural Heritage Program through 1998, documented 13 to 16 occurrences at various separation distances and estimated more than 14,000 individuals across approximately 368 hectares of occupied habitat in Nevada (NNHP 2001).

The BLM Las Vegas Field Office conducted surveys of the four Clark County population groups in 1994, 1996, and 1997, which were subsequently summarized and synthesized in TNC (2007). Hidden Valley and adjacent areas were surveyed in 1994, yielding 8,775 individuals across approximately 324 hectares at seven sites spanning portions of all four Clark County population groups, with approximately 85 percent of data points described as heavily disturbed (Sheldon 1994, as cited in TNC 2007). BLM surveys at the Jean Lake population group in 1996 estimated 2,381 to 13,456 individuals across an areal extent of approximately 2,188 acres, with 53 percent of data points showing no disturbance (TNC 2007). The 1996 Ivanpah Valley surveys estimated 3,201 to 13,917 individuals across approximately 2,465 acres, the largest extent of any Clark County population, and approximately 89 percent of data points showed no disturbance (TNC 2007). Roach Lake surveys in 1997 estimated 217 to 989 individuals across 157 acres (TNC 2007). Based on these surveys, the Ivanpah Valley population group was assessed as exhibiting the best overall viability among the Clark County populations (TNC 2007).

Smith (2001) conducted a status assessment for *P. albomarginatus* based on surveys in the late 1990s, estimating 25,964 plants in Clark County and 42,200 plants in Nye County.

A Clark County Desert Conservation Program-funded study conducted by the Nevada System of Higher Education from October 2007 through September 2009 investigated sediment transport processes in relation to *P. albomarginatus* habitat at seven instrumented field sites in Clark and Nye counties. Population resurveys of all 12 known occurrences documented in the 1997 to 1998 Smith surveys yielded revised estimates of approximately 125,825 plants in Clark County and 78,954 plants in Nye County, approximately five times and two times the earlier estimates, respectively; the authors note that

the two methods are not directly comparable and that inter-annual variation is substantial. Phenology monitoring at the four Clark County sites found that drought and insect herbivory reduced reproductive success in 2009, with seed dispersal observed only at the Hidden Valley site, at distances of 1 to 15 centimeters (Etyemezian et al. 2010).

ICF Jones & Stokes (2010), under contract with the Clark County Desert Conservation Program, conducted rare plant inventories at 511 survey plots across 13 Geographic Units throughout Clark County between April 2009 and May 2010, with white-margined beardtongue among the ten target species. White-margined beardtongue was the least commonly encountered of the ten target species, located only once during the surveys and within a survey plot rather than as an incidental observation (ICF Jones & Stokes 2010).

The 2020 rare plant survey conducted by Ironwood Consulting encountered white-margined beardtongue at four locations within the Jean Dry Lake survey area. In total, these occurrences included 8,691 individuals occupying 55 acres across an elevation range of 863 to 912 meters, and ranged from fair to excellent in quality. Common associated species included *Ambrosia dumosa*, *Larrea tridentata*, *Malacothrix glabrata*, and *Pleuraphis rigida*. The annual invasive *Schismus* sp. was encountered across all occurrences. Immediate threats to these occurrences included moderate to high levels of off-highway vehicle use (including evidence of frequent travel off designated routes) and potential solar development (Ironwood Consulting 2020).

Ironwood Consulting's 2021 rare plant survey targeted sandy habitats within Clark County but did not encounter *P. albomarginatus* during that survey season. Two consecutive years of below-average moisture conditions were noted as having reduced the abundance and vigor of perennial plants across survey areas, and the areas of true suitable habitat for this species in Clark County are limited (Ironwood Consulting 2021).

A recent comprehensive range-wide survey found 68,535 plants across all four populations in 2021 (Miller 2021), reflecting a substantial decline from the peak abundance estimate documented between 1988 and 2010.

Ironwood Consulting's 2023 rare plant survey found white-margined beardtongue at the Hidden Valley Disposal and Jean Lake East survey areas. One of these locations represents a new occurrence record, while the other is within 0.5 mile of an existing record. The total occupied area included approximately 0.3 acres and 11 individuals. Both occurrences were rated poor in quality due to small population size and proximity to highly trafficked off-highway vehicle routes. The 2023 survey also revisited a historic element occurrence record for *P. albomarginatus* in the "Revisit PEAL" survey area, where the plant community was dominated by Utah juniper and singleleaf pinyon on limestone-derived substrate, clearly unsuitable habitat for this species. No individuals were observed, suggesting the historic record was likely a misidentification or contained incorrectly recorded locality details (Ironwood Consulting 2023).

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Eastern Joshua Tree (*Yucca jaegeriana*)

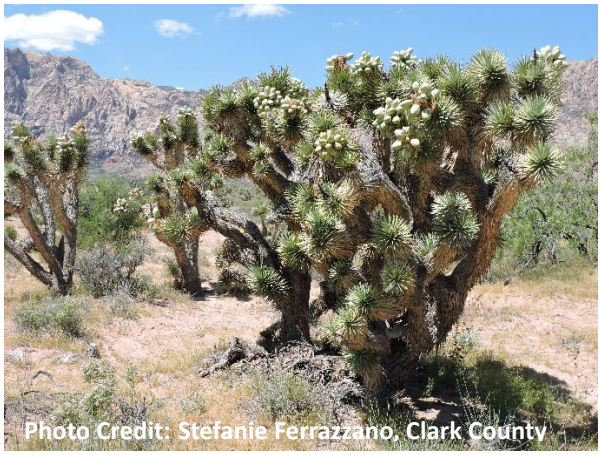
Photo Credit: Stefanie Ferrazzano, Clark County

Photo Credit: Stefanie Ferrazzano, Clark County

Species Overview

The eastern Joshua tree (*Yucca jaegeriana*) is a large, tree-like, evergreen monocot of the family Asparagaceae, occupying mid- to upper-elevation zones of Mojave Desert shrubland communities (McKelvey 1938; Rowlands 1978; Cole et al. 2011). The species was historically treated as a variety of *Yucca brevifolia* (Joshua tree), but was elevated to species rank based on morphological, pollination, and genetic distinctions (Lenz 2007; Royer et al. 2016), and USFWS recognizes both *Y. jaegeriana* and *Y. brevifolia* as distinct species (USFWS 2019). Compared to the western Joshua tree, *Y. jaegeriana* is generally smaller, with plants typically 3 to 6 meters tall, branching from near the base, with more slender branches and shorter leaves of 10 to 20 centimeters in length; the flowers are narrowly campanulate with greenish, recurved perianth segments, and the fruits are ellipsoid and tapering at the tips (Lenz 2007).

Eastern Joshua trees require their own species of *Tegeticula* moth (*Tegeticula antithetica*) for pollination, and the moths in turn require the ripening seeds of the Joshua tree as sustenance for their developing larvae (Trelease 1893; Pellmyr and Segraves 2003). This obligate pollination mutualism is species-specific: *Y. brevifolia* is pollinated by *Tegeticula synthetica*, a distinct and morphologically dissimilar moth species (Pellmyr and Segraves 2003). Successful reproduction and growth to maturity of Joshua trees requires a remarkable coincidence of appropriate environmental and biological conditions (DeFalco et al. 2010). Mortality for adult Joshua trees is usually relatively low (approximately two to three percent per year or less), but severe drought can cause increased mortality, and drought effects are more severe on smaller Joshua trees (DeFalco et al. 2010). Joshua trees are important to many wildlife species across the Mojave Desert (Miller and Stebbins 1964) and may be considered an umbrella species in this region.

Joshua trees generally flower and seed unpredictably only every few years, a pattern called masting (SWECO 2018). With sufficient precipitation, some seeds escape moth larvae predation and develop within pithy, indehiscent fruits that require rodents or erosion to break them up and release the seeds for dispersal (SWECO 2018). Many seeds are consumed by seed-caching rodents and other granivores, but caches that are forgotten or overlooked are well placed for germination and establishment at approximately 2 centimeters deep in the soil (SWECO 2018). Joshua tree seeds exhibit high germination rates when stored dry, but seeds in the ground deteriorate rapidly after about 18 months, such that no persistent seed bank is maintained for future generations; seeds that germinate during summer rains have a greater chance of survival than those germinating after spring rains, as summer germinants avoid harsh conditions during their first year of root and shoot development (SWECO 2018). Predation by herbivores can reach 50 percent in a single year for

Joshua trees less than 1 meter tall, and it may require 30 years for plants to reach this stature; small Joshua trees benefit from growing beneath nurse plants such as white bursage (*Ambrosia dumosa*) and blackbrush (*Coleogyne ramosissima*), which may also offer protection from herbivores (SWECO 2018). Joshua trees may begin to flower when they reach approximately 1 meter in height, but most plants do not attain reproductive size until about 70 years of age (SWECO 2018). During drought, herbivory may increase as white-tailed antelope ground squirrels (*Ammospermophilus leucurus*), black-tailed jackrabbits (*Lepus californicus*), woodrats (*Neotoma* spp.), and pocket gophers (*Thomomys bottae*) turn to Joshua trees as a last-resort food source, and such events have resulted in high levels of Joshua tree mortality across large areas (SWECO 2018).

Beyond the obligate yucca moth mutualism, a diverse community of invertebrates feeds on the flowers, fruits, and stems of Joshua trees, and the seeds provide forage for rodents such as Merriam's kangaroo rat (*Dipodomys merriami*), white-footed mice (*Peromyscus* spp.), and woodrats (*Neotoma* spp.), as well as for harvester ants including the rough harvester ant (*Pogonomyrmex rugosus*) (SWECO 2018). Raptors such as red-tailed hawk (*Buteo jamaicensis*) and great horned owl (*Bubo virginianus*) use Joshua trees as hunting perches and nesting platforms, and western screech-owl (*Megascops kennicottii*) and American kestrel (*Falco sparverius*) use them as hunting perches or nesting cavities (SWECO 2018). Northern and gilded flickers (*Colaptes auratus* and *C. chrysoides*) and ladder-backed woodpecker (*Dryobates scalaris*) use Joshua trees as these are among the only species in which they can excavate nesting cavities in the Mojave Desert, and these cavities are secondarily used by small owls, ash-throated flycatcher (*Myiarchus cinerascens*), and honeybees (SWECO 2018). Perching birds such as western kingbird (*Tyrannus verticalis*), loggerhead shrike (*Lanius ludovicianus*), and cactus wren (*Campylorhynchus brunneicapillus*) perch and nest among Joshua tree branches; loggerhead shrikes also use the sharp leaf tips to impale prey such as lizards, snakes, and scorpions as a larder from which to feed their young (SWECO 2018).

Range

The eastern Joshua tree is endemic to the United States and occurs primarily within the Mojave Desert, including portions of western Arizona, southeastern California, southern Nevada, and extreme southwestern Utah (USFWS 2018; NatureServe 2021). To the north, its range extends into the Great Basin Desert, and to the east into the Sonoran Desert of Arizona (USFWS 2018). The range of *Y. jaegeriana* overlaps with that of *Y. brevifolia* only in a small area of Tikaboo Valley in Lincoln County, Nevada, where the two species hybridize (Lenz 2007; Royer et al. 2016). The range extent of *Y. jaegeriana* is approximately 20,000 to 200,000 square kilometers (NatureServe 2021).

Yucca jaegeriana is the only Joshua tree species known to occur in Clark County, Nevada (SWECO 2018). Joshua trees are widespread in Clark County and occupy higher-elevation valley bottoms, bajadas, and lower mountain slopes. They occur across a range of soil origins, including granite, volcanic, sandstone, and various limestone substrates including dolomite, but generally do not occur in the very fine soil textures of playas in lower valley bottoms (SWECO 2018). Joshua trees within Clark County typically occur at elevations of 2,500 to 4,500 feet (Benson and Darrow 1981; Rowlands 1978; Cole et al. 2011).

Within Clark County, eastern Joshua tree stands occur around the western base of the Virgin Mountains and across other areas of similar elevation within Gold Butte National Monument, and farther north on the Mormon Mesa in shallow sandy hollows atop mudstones (SWECO 2018). The valleys, bajadas, and lower mountain slopes between the Arrow Canyon Range and the Desert Range support extensive, high-quality Joshua tree habitat, although portions of that area have been damaged by wildfire; additional extensive stands occur on the west side of the Desert Range and in valleys on the Nevada Test and Training Range

(formerly the Nellis Bombing Range) (SWECO 2018). Much of the desert habitat on the north side of the Spring Mountains and south of State Route 95 supports sparse to moderately dense Joshua tree stands, and Joshua trees nearly encompass the Spring Mountains, Mount Potosi (except for areas burned multiple times), and the Stateline Mountains (SWECO 2018). The most extensive and robust Joshua tree populations in Clark County occur along U.S. Highway 93 north and south of Searchlight and westward to the California state line, an area that includes Clark County's Joshua Tree Highway; this population extends across low passes in the McCullough Mountains and into the adjacent valley toward Sheep Mountain (SWECO 2018).

Habitat Characteristics

The eastern Joshua tree is somewhat of a habitat generalist and occurs on flats, gentle slopes, mesas, and bajadas on a variety of substrates, typically igneous but also silty, loamy, or sandy soils, within many different plant communities that range from Yellow Pine Forest to Sonoran Desert (Lenz 2007; USFWS 2018). The species has some tolerance for saline and alkaline conditions but tends to occur in areas with precipitation distributed relatively consistently throughout the year, although total annual precipitation varies across its range (Lenz 2007; USFWS 2018). *Yucca jaegeriana* tolerates winter lows of approximately 4 degrees Celsius (39 degrees Fahrenheit) and summer highs of approximately 46 degrees Celsius (110 degrees Fahrenheit) (USFWS 2018).

Nurse plants are important for successful seedling establishment by providing favorable microclimates and protection from herbivory (USFWS 2018). Seed-caching rodents have been documented as caching Joshua tree seeds within 30 meters of host plants, contributing to short-distance seed dispersal (Vander Wall et al. 2006). The presence of rhizomes also allows for vegetative (asexual) spread of the species (USFWS 2018). The historical long-distance seed disperser of the Joshua tree, the Shasta ground sloth (*Nothrotheriops shastensis*), went extinct at the end of the Pleistocene, and the absence of an effective long-distance disperser is now considered a significant constraint on the ability of Joshua trees to shift their range in response to environmental change (Cole et al. 2011; Lenz 2001).

Habitat Suitability Model

Simandle and Nussear (2025) developed an ensemble habitat suitability model for the eastern Joshua tree within Clark County using generalized additive models, generalized boosted regression models, MaxEnt, and random forests. The ensemble model performance values indicate a robust model with the ability to discriminate areas of suitable habitat, with testing values of Area under the Receiver Operator Curve = 0.8645 (SD = 0.0008), TSS = 0.7708 (SD = 0.0042), and BI = 1.0 (SD = 0.0) (Simandle and Nussear 2025). The continuous BI curve indicates that as the habitat suitability estimate increases above approximately 80 percent, species presence is predicted up to three times greater than would be expected at random (Simandle and Nussear 2025).

The top four variables contributing to the ensemble model were the coefficient of variation of minimum temperature (CVMinTemp), winter precipitation (wp), coefficient of variation of winter precipitation (wpcv), and annual precipitation (ppt) (Simandle and Nussear 2025). Habitat suitability for *Y. jaegeriana* is highest when CVMinTemp is approximately 2.2 and decreases dramatically when CVMinTemp exceeds 2.5; when winter precipitation is approximately 160 millimeters; when wpcv is between 0.55 and 0.68; and when annual precipitation is approximately 180 millimeters (Simandle and Nussear 2025).

Highly suitable habitat for the eastern Joshua tree is broadly distributed across Clark County and the buffered modeling area (Figure 29). Primary areas of highly suitable habitat are found at mid-range elevations, with high suitability generally occurring along the periphery of mountain ranges and low

suitability in valley bottoms and at extreme elevations (Simandle and Nussear 2025). The locality data used to develop the model consisted of a very large number of records within the buffered modeling area with a high degree of spatial overlap; spatial thinning reduced the number of localities used for training and testing to 54,653 records (Simandle and Nussear 2025).

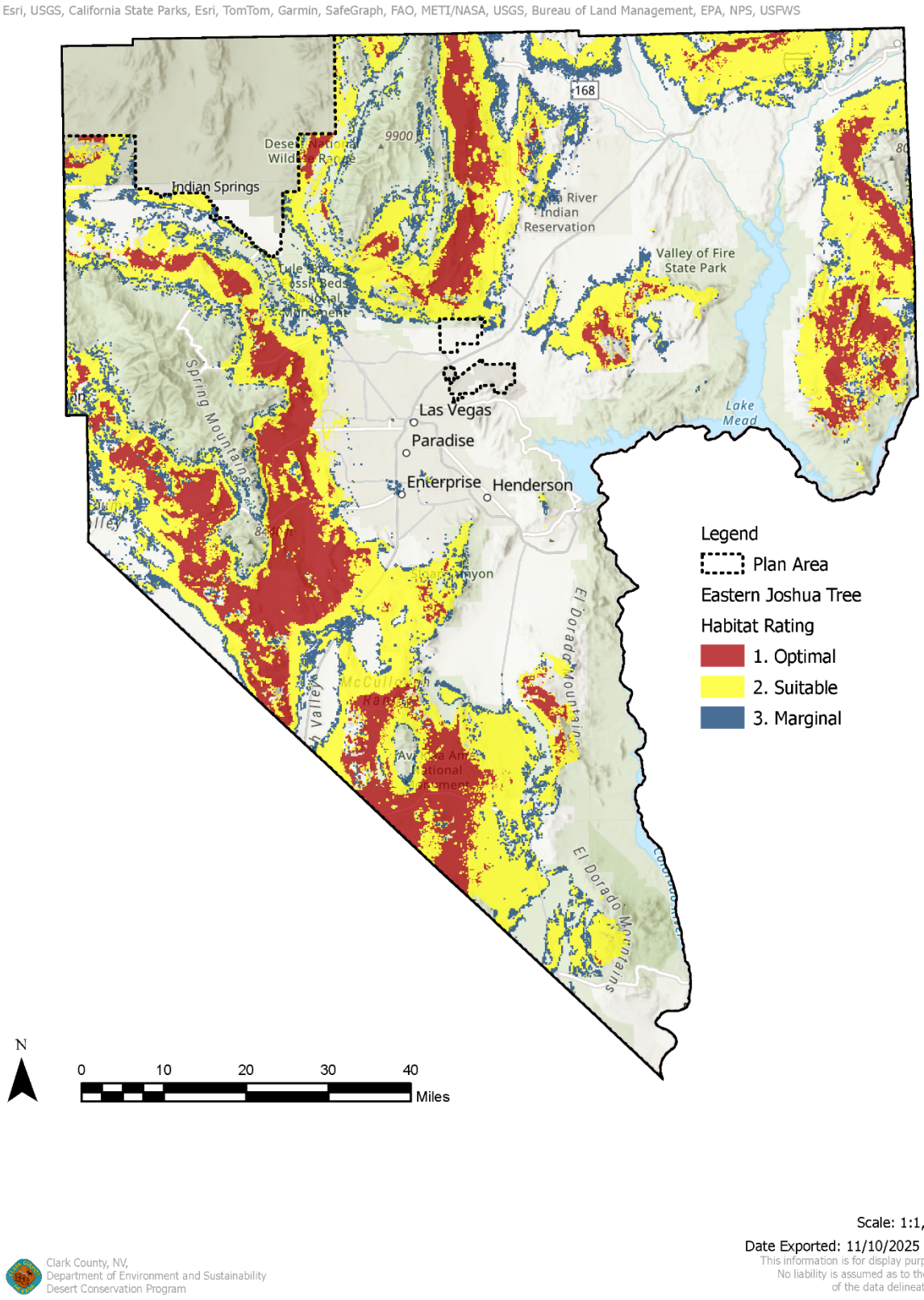

Figure 29. Habitat suitability model for the eastern Joshua tree (*Yucca jaegeriana*) in Clark County, Nevada (Simandle and Nussear 2025).

Species Status

Agency/Organization	Status
MSHCP (2000)	None
U.S. Fish and Wildlife Service Endangered Species Act	None
U.S. Bureau of Land Management (Nevada, 2023)	Sensitive
U.S. Forest Service (Region 4)	None
State of Nevada	State Code prohibits commercial collection
State of California	State Candidate
State of Arizona	None
NV Division of Natural Heritage	None
NV Climate Change Vulnerability Index	Not Addressed
NatureServe Global and NV State Rank	G3G4 S3S4
IUCN Red List (v 2025-2)	Least Concern
CITES	None

* SNR – Status not ranked at the state level for species or subspecies.

The eastern Joshua tree is not currently listed as threatened or endangered under the federal Endangered Species Act. In September 2016, USFWS issued a 90-day finding indicating that listing the Joshua tree may be warranted and initiated a status review (USFWS 2016). In August 2019, USFWS completed a 12-month finding on the petition and determined that listing both *Y. brevifolia* and *Y. jaegeriana* was not warranted at that time (USFWS 2019). The 2019 finding was subsequently challenged, and USFWS revised the Species Status Assessment and conducted a new 12-month finding. On March 9, 2023, USFWS published a notification of finding concluding that, after a thorough review of the best available scientific and commercial information, listing Joshua trees as endangered or threatened species was not warranted (USFWS 2023). Joshua trees are included in the USFWS FY23-27 National Domestic Listing Workplan (USFWS 2023).

The eastern Joshua tree is ranked G3G4 globally and S3S4 in Nevada by NatureServe, indicating a vulnerable to apparently secure status (NatureServe 2021). It is ranked S3 in Arizona, S1 (Critically Imperiled) in Utah, and SNR (status not ranked) in California (NatureServe 2021). The species is listed as Least Concern on the IUCN Red List. *Yucca jaegeriana* is designated as Sensitive by the BLM in Nevada (BLM 2023), and a State Candidate in California.

Under Nevada Revised Statutes Chapter 527, eastern Joshua trees, as members of the genus *Yucca* are protected from unpermitted removal. The commercial removal or possession of yucca requires registration, a shipping permit, and tags issued by the State Forester Firewarden (NRS 527.060 to 527.120), and the cutting, destruction, mutilation, or removal of any tree, shrub, or flora from private or state lands without the landowner's written permission or compliance with applicable state regulations is unlawful under NRS 527.050.

Population Trends

The long-term population trend for the eastern Joshua tree reflects an estimated decline of 10 to 30 percent, driven primarily by development around Las Vegas, Henderson, and Pahrump, Nevada (USFWS 2018; NatureServe 2021). The short-term population trend is currently unknown (NatureServe 2021). Joshua trees are abundant where they occur across many locations in the Mojave Desert (Cole et al. 2011), including Clark County, Nevada. While population studies on Joshua trees are ongoing (Esque et al. 2010), no existing research projects are of sufficient scale to determine the population status of either Joshua tree species across Clark County, Nevada, or similar areas of comparable size (SWECO 2018).

Habitat Level Threats

The primary habitat-level threats to the eastern Joshua tree in Clark County are development and wildfire associated with invasions of non-native annual grasses, particularly red brome (*Bromus madritensis*) (SWECO 2018). Increased fire frequency, fueled by non-native annual grasses that produce heavy fuel loads, is among the most severe threats to the species and its associated plant communities, neither of which is especially tolerant of fire (USFWS 2018; Cole et al. 2011). Native plants responding with vigorous growth to an unusually wet winter also contribute to increased fuel loads and have been associated with past fires. Development is most evident as a threat to Joshua tree populations on the west side of the Las Vegas Valley (SWECO 2018).

Fire history within Clark County illustrates the scale of wildfire risk to eastern Joshua tree populations. Numerous old fire scars around the base of the Spring Mountains, and a smaller number around the McCullough Mountains, likely resulted from earlier forest fires that dropped from surrounding forests and woodlands into adjacent desert shrublands (SWECO 2018). More recently, low-elevation desert shrubland has burned following red brome invasions; large landscape-scale fires associated with the Southern Nevada Fire Complex of 2005 consumed substantial expanses of desert habitat in Clark County, much of it Joshua tree habitat, including areas of Hidden Valley, near Coyote Springs, and in Gold Butte (SWECO 2018). Over the past 15 years, additional large fires have occurred in the Desert Range and Arrow Canyon area, on northern Mormon Mesa, and in what is now Gold Butte National Monument (SWECO 2018). Habitat fragmentation associated with development further promotes the incursion of invasive grasses and provides additional ignition sources, thereby increasing fire risk (SWECO 2018).

Additional habitat-level threats include habitat loss and degradation from residential and urban development, military activities, renewable energy development, livestock grazing, and off-road vehicle use (USFWS 2018). Approximately 0.7 percent of the species range occurs in areas with residential and urban development, and approximately 8.5 percent is located on military lands; the species is not believed to be substantially impacted by military activities and may benefit from management plans and conservation efforts on those lands (USFWS 2018). Approximately 53 percent of the species range falls within grazing allotments, although not all are actively grazed; grazing animals browse plants and flowers below 2 meters in height, trample young plants, and contribute to a loss of soil structure that can degrade habitat (USFWS 2018). Off-road vehicle use can be severe where it occurs and can cause mortality to Joshua trees and their nurse plants, damage to the seed bank, and degradation of soil structure (USFWS 2018).

The eastern Joshua tree is expected to be negatively affected by climate change through increased temperatures, intensified drought, and shifts in precipitation timing (Cole et al. 2011; Barrows and Murphy-Mariscal 2012; USFWS 2018). While the species is generally tolerant of drought, young plants and seedlings experience greater mortality and lower germination success under drought conditions. The species range is

predicted to become drier and hotter, with suitable habitat shrinking and shifting northward and to higher elevations in climatic refugia (USFWS 2018). It has been demonstrated that Joshua tree stands in parts of Joshua Tree National Park are not reproducing rapidly enough to keep pace with natural declines of the populations (SWECO 2018).

Threats to Species

Direct threats to individual eastern Joshua trees in Clark County include destruction due to vandalism, removal during development, and rodent damage during drought periods (SWECO 2018). Younger, smaller plants are more vulnerable to mortality from wildfire than older, larger plants; one cause of post-fire mortality is predation by small mammals seeking a food source (USFWS 2018; Cole et al. 2011). Native herbivores also cause damage and mortality to the species (USFWS 2018).

The York Fire, ignited on July 28, 2023, in the New York Mountains of the Mojave National Preserve in San Bernardino County, California, crossed the state line into Clark County, Nevada, on July 30, 2023, and burned into Avi Kwa Ame National Monument before it was contained on August 19, 2023 (York Fire 2025). The fire ultimately burned 93,078 acres across the two states, burning through groves of Joshua trees, including one of the densest Joshua tree forests in the region, and Joshua trees within the burn area sustained direct mortality (Salahieh and Gilbert 2023). Conditions contributing to the fire's spread were consistent with the broader pattern of increased fire frequency across the Mojave region over the preceding decade, which has been attributed to the combination of wet winters, including the wet winter of 2022 to 2023, and rising levels of invasive annual grasses that load desert shrublands with fine fuels (Salahieh and Gilbert 2023; York Fire 2025).

With the extinction of the Shasta ground sloth, the species' primary long-distance seed disperser, at the end of the Pleistocene, the ability of Joshua trees to shift into newly suitable habitat in response to environmental change is substantially limited (Cole et al. 2011). Seedlings of Joshua trees do not rapidly develop the thick, water-storing taproots characteristic of young plants of co-occurring *Y. baccata* and *Y. schidigera*; instead, young Joshua trees rely on available moisture to become established, making them especially vulnerable to drought during the establishment phase (Lenz 2007).

Conservation and Management

Among the largest stands of protected eastern Joshua trees in Clark County are those within Gold Butte National Monument and the wilderness areas therein. Additional protection is afforded in Lake Mead National Recreation Area, Red Rock Canyon National Conservation Area, the Desert National Wildlife Refuge, and the BLM's Wee Thump Joshua Tree Wilderness. Some areas within Clark County that have experienced past wildfire will likely benefit from ongoing restoration efforts conducted by federal, state, and county agencies (SWECO 2018). Plants also receive some protection from local ordinances in parts of the species' range (USFWS 2018).

Preliminary active restoration projects targeting eastern Joshua tree are underway in Clark County and include the outplanting of young Joshua trees and the distribution of Joshua tree seed together with other experimental treatments; this work is sponsored by the BLM Las Vegas Field Office, with research and monitoring provided by the USGS Western Ecology Research Center (SWECO 2018).

Based on this habitat suitability modeling, approximately 1,990,707 acres of suitable Joshua tree habitat occur within the MSHCP Amendment Plan Area. Of this total, 67,434 acres (3.4 percent) fall within the MSHCP Amendment Impact Area. Approximately 67.1 percent of suitable habitat (1,335,236 acres) is located

within lands managed for resource conservation. Within the existing MSHCP Reserve System, only 122 acres (less than 0.1 percent) of suitable habitat are currently conserved. The MSHCP Amendment Reserve System Additions would incorporate an additional 167,754 acres, representing 8.4 percent of total suitable habitat within the Plan Area.

Eastern Joshua tree (*Yucca jaegeriana*)	Acres	Percent of Total Habitat within Plan Area
Suitable Habitat in the MSHCP Amendment Plan Area	1,990,707	n/a
Suitable Habitat in the MSHCP Amendment Impact Area	67,434	3.4%
Suitable Habitat in Lands Managed for Resource Conservation	1,335,236	67.1%
Suitable Habitat in the existing MSHCP Reserve System	122	0.0%
Suitable Habitat in the MSHCP Amendment Reserve System Additions	167,754	8.4%

*Simandle and Nussear 2025

Clark County Survey Data

No Clark County Desert Conservation Program surveys specifically targeting *Yucca jaegeriana* have been completed. Given the species' widespread distribution and abundance across Clark County, targeted surveys have not been considered a priority. Joshua trees are abundant where they occur across many locations in the Mojave Desert, including Clark County (Cole et al. 2011). Population-level studies on Joshua trees have been conducted by other researchers in the region, including demographic studies of Joshua trees in Mojave Desert national parks with an emphasis on germination and recruitment (Esque et al. 2010); however, no existing research is of sufficient scale to determine the population status of the eastern Joshua tree across Clark County (SWECO 2018).

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Appendix B

Seed Collection Protocol for Covered Plant Species

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1.0 Seed Collection General Information

1.1 Access Permits, Vouchers, and Seed Collection Timing

1. Collection teams shall have a copy of all permits and permission letters with them at all times when visiting sites or collecting seeds for this effort. The documents shall include:
   a) a landowner permission memo or letter,
   b) MSHCP permit, and
   c) NDF collection/master permit for each taxon to be collected.

1.2 Focal Species Identification and Vouchers

1. Focal species (Covered Plant Species and other species targeted for seed collection) shall be identified in the field by persons who are familiar with the identifying characteristics of each taxon and have demonstrated ability to identify each Focal species at different life stages.
2. Voucher herbarium specimens and digital voucher photos (collectively, vouchers) shall be made.
   a) A minimum of three digital voucher photos shall be taken to document each taxon, the seeds or fruits collected, and the habitat where collection is to be made.
   b) Voucher herbarium specimens shall be made to document the range of variability of each Focal species at that site.

1.3 Seed Collection Timing

1. Persons familiar with the identifying characteristics of each Focal species shall make determinations of seed maturity at each collection site.
2. General collection season suggestions for each Covered Plant Species are provided in Table 1 below. Other Focal species to be included will have overlap in the collection season with the Covered Plant Species targeted for collection.

TABLE 1. COVERED PLANT SPECIES SEED COLLECTION SEASON RECOMMENDATIONS

Common Name	Scientific Name	Mature Seed Collection Season[1]
sticky ringstem	*Anulocaulis leiosolenus* var. *leiosolenus*	August – October
Las Vegas bearpoppy	*Arctomecon californica*	May – July
threecorner milkvetch	*Astragalus geyeri* var. *triquetrus*	June – September
Blue Diamond cholla	*Cylindropuntia multigeniculata*	July – August
silverleaf sunray	*Enceliopsis argophylla*	June – July
Pahrump Valley buckwheat	*Eriogonum bifurcatum*	June – August
Las Vegas buckwheat	*Eriogonum corymbosum* var. *nilesii*	October – December
white-margined beardtongue	*Penstemon albomarginatus*	June – July
Eastern Joshua tree	*Yucca jaegeriana*	July – September

[1] Specific seed collection timing will depend on locational factors such as elevation, and climatic conditions during the year in which collection takes place.

2.0 Seed and Data Collection

2.1 Seed Collection Methods

1. In Zone A, 100 percent of available mature seed will be collected during seed collection efforts from all Covered Plant Species found on lands accessible to the Desert Conservation Program (DCP) that may be disturbed by Covered Activities during construction. For private property, the DCP will be notified of planned disturbance upon submittal of project plans to a Permittee for review and approval.
2. In Zone B, 50 percent of available mature seed will be collected within the disposal boundary, except for Eastern Joshua tree and Blue Diamond cholla for which 100 percent of mature available seed will be collected, as practicable.
    a) For private property in Zone B, if a project is proposed in areas likely to support occurrences of Covered Plant Species based on the species accounts and habitat models, the DCP will request landowner permission to access the property for seed collection prior to disturbance.
    b) For lands within a proposed disposal boundary, the DCP will coordinate with BLM to require seed collection before parcels go to auction for BLM disposal. Surveys will be conducted to confirm presence of Covered Plant Species prior to seed collection, and the surveys will provide updated information on Covered Plant Species locations and recommended timing for seed collection. If seed collection is completed prior to transfer of disposal lands to private landowners, no further seed collection is required prior to disturbance. If seed collection is not completed prior to transfer to private land ownership, the protocol in Section 2.1.2.a will be followed.
    c) In collaboration with regional seed collection programs such as the U.S. Fish and Wildlife Service's proposed "Promoting Native Plants for Restoration, Landscaping, and Water Conservation" program, additional seeds of native plant species beyond the targeted Covered Plant Species may be collected. Additional Focal species and percentage of seed to be collected will be coordinated with the regional program lead. Seeds of additional native plant species may also be collected if native seed stocks for MSHCP Amendment restoration projects need to be augmented. In these instances, Focal species and percentage of seed to be collected will be based on MSHCP Amendment restoration project needs.
3. All plants shall be examined in the field for seed maturity prior to seed collection, and only mature seeds will be collected.
    a) Prior to fruit maturation, cloth bags may be placed around ripening fruits of Las Vegas bearpoppy, threecorner milkvetch, and white-margined beardtongue to capture the maximum number of seeds as the fruits naturally dry and split open.
    b) Paper bags or envelopes shall be used to collect seeds of all species in the field. Seams at the bottom of paper bags or envelopes shall be taped to ensure that small seeds do not fall out. Large collections can be made using plastic buckets and then transferred into cloth or paper bags.
    c) Efforts shall be made to minimize excess plant material (chaff) collected with seed.
    d) Seeds collected at a single location for a single taxon shall be bagged together.
    e) All collection will be conducted by hand because of the limited number of species to be collected. However, if the scale of seed collection at a site warrants other methods, the DCP will coordinate

with the U.S. Fish and Wildlife Service for approval of alternate collection methods for Covered Plant Species, or with the regional seed collection program lead for other Focal species.

2.2 Data Collection

1. During seed collection, data about each collection of seed shall be recorded on data sheets or in a digital data logger form.
   a) Separate data sheets or forms shall be completed for each taxon collected at each locality (see Attachment 1).
   b) Data recorded shall include the date and location of the area where collection is made, collector name(s), description of the microhabitat where the taxon was found, voucher photos and voucher herbarium specimens collected, and the approximate number of plants from which the seeds were collected.
   c) Notes shall be made if there is any indication that the occurrence may be non-natural or the result of human actions (for example, plants growing on spoil piles or in gravel that appears to have been transported to the site).
   d) Data sheets or forms shall note that the collected seeds are the property of the DCP.

3.0 Collection Treatment and Storage

3.1 Post Collection Treatment of Seed, Vouchers and Data

1. Collected seed, data, and vouchers shall be transported to and stored at the Las Vegas Springs Preserve horticultural laboratory or equivalent seed cleaning and storage facility.
   a) Seeds
      i) Collected seed materials shall be initially stored in an area with moderate temperatures, low relative humidity, and good air circulation prior to seed cleaning. Do not freeze seeds.
      ii) Collected seed materials shall be cleaned to remove excess chaff and other materials prior to long-term storage.
      iii) Cleaned seeds shall be placed in woven PVC, polyethylene (such as Tyvek®), or nylon packets, or equivalent.
      iv) Seed packets shall be cataloged and stored inside a rodent- and insect-resistant container.
      v) If seeds need to be shipped for cleaning or storage, protocols from the Bureau of Land Management Seeds of Success program will be followed.
   b) Vouchers
      i) Voucher photos shall be stored and labeled by taxon, date, and collection location, or by collection accession number as appropriate.
      ii) Voucher herbarium specimens shall be pressed and mounted on herbarium sheets for all collections made, and shall be deposited in the Wesley Niles Herbarium at the University of Nevada Las Vegas (or equivalent facility).
      iii) Voucher photos and lists of prepared and deposited voucher herbarium specimens will be provided to the DCP with periodic reports.

c) Data

i) Collection field data sheets shall be transcribed, or digital data forms uploaded, into a seed collection database, and the originals stored as a backup.

ii) Periodic reports on the disposition of collected and stored seeds shall be provided to the DCP by the seed storage facility, and these reports will be available from the DCP for inspection upon request.

4.0 Allowable Uses of Collected Seed

Seeds will be stored as described above and made available for regional use in restoration, propagation, and research. Use of the seeds will not be exclusive to MSHCP Amendment projects. The seeds collected as part of the MSHCP Amendment will help supply regional programs and seed banks with a locally and regionally appropriate seed source. MSHCP Amendment restoration projects will obtain seed from the same regional storage facility or program, or from other appropriate native seed source programs or businesses.

A portion of seeds collected from Zones A and B (no greater than 20 percent) will also be offered to international and national seed banks that seek to preserve the genetic diversity of native species. Several of these seed banks allow the donor to withdraw seeds if requested. These include member institutions of the Center for Plant Conservation; the U.S. Department of Agriculture, Fort Collins National Center for Genetic Resources Preservation and their National Collection of Endangered Plants; and the Royal Botanic Gardens, Kew Millennium Seed Bank, or equivalent.

Attachment 1. Covered Plant Species Seed Collection Data From

PRE-COLLECTION CHECKLIST

This section is for your reference only and not required as part of the data collected by the Desert Conservation Program for the Clark County Multiple Species Habitat Conservation Program. The conditions indicated in **boldface** *describe ideal population size and seed dispersal stage for seed collecting.*

Assess Population & Seed Dispersal Stage
Approximate area of population: (feet, yards, miles……)
Approximate total number of individual plants present and accessible: *0-50* *50-500* *500-5000* *> 5000*
Evidence of disturbance or damage: *Resown* *Burnt* *Sprayed* **No damage**
Readiness of population for seed collection: give percentages or circle the most frequently occurring: *Vegetative* *In flower* *Immature seeds* **Around natural dispersal** *Post dispersal*
Estimate the number of individual plants at natural dispersal stage: *<50* **>50**
Is the population: ***A single population*** *A population with distinct sub-populations* (Can you sample separately or from the most suitable?)
Assess Seed Quality & Availability
On a typical individual, where on the plant/branch/fruit is the seed at natural dispersal stage: **Recognized**
Using a cut test on the seeds at this stage, give percentages or circle the most frequently occurring: **Healthy** *Insect-damaged* *Empty* *Moldy* *Malformed/other damage*
Estimate the number of healthy seeds per fruit:
Estimate the number of fruits per individual plant:

Data Collection form on the following pages.

Date(s) collected:		**Collector name(s):**	
		Collection number:	

LOCATION DATA

State:		**Land owner:**	*BLM Private Other*
County:		**Non-BLM permission filed:**	
Location details:			
GPS type:			
Spatial data Info (coordinates, polygon name, file type, etc.):			

COLLECTION DATA

Family:		**No. of plants sampled** (estimate)**:**	
Genus:		**No. of plants found** (estimate)**:**	
Species:		**Area sampled** (acres)**:**	
Subspecies/Variety:		**Seeds collected from:**	*Plants Ground Both Unknown*
Common name:			
Growth form:	*Tree Annual Herb Perennial Herb Succulent or Cactus*		
Field notes to assist in identification of pressed specimen (e.g. flower color)**:**			
Seed storage location:			

LOCATION DATA

State:			
County:			
Land owner:	*BLM Private Other*	**Non-BLM permission filed:**	Y N
Location details:			

HABITAT DATA

Associated species:	
Microhabitat description:	
Modifying factors:	*Mowed Burned Grazed Flooded Seeded Trampled Other:*

Evidence of Non-natural Population? (i.e. plants growing on spoil piles, or transported material)**:**			
Land form:		**Slope** (degrees)**:**	
Land use:		**Aspect:**	*N NE E SE S SW W NW*
HERBARIUM AND PHOTO VOUCHERS			
Number of photo vouchers:		**Photo numbers:**	
Number of pressed specimens:		**Voucher ID numbers:**	
Receiving Herbaria Names:			
SPECIALIST IDENTIFICATION			
Identified by (include name, organizational affiliation):			
Note: Collected seeds are the property of the Desert Conservation Program			

Appendix C

Desert Tortoise Clearance Survey Protocol

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Attachment 1 - Desert Tortoise Clearance Survey Data Form

1.0 Qualified Biologist Definition

As described in Section 6.3.3.2 of the MSHCP Amendment, the following terms and definitions will be used to determine qualified biologists to conduct desert tortoise clearance surveys and handling. Survey and clearance guidance is based on the U.S. Fish and Wildlife Service (USFWS) Field Manual[1], the Clearance Survey Protocol for the Mojave Desert Tortoise,[2] and "Preparing for Any Action that may Occur within the Range of the Mojave Desert Tortoise (*Gopherus agassizii*)"[3] with notable exceptions. The USFWS guidelines are designed to provide a high degree of certainty that as many desert tortoises as possible will be found. In contrast, under the MSHCP, incidental take is authorized; thus the purpose of these protocols is to minimize incidental take rather than to ensure that no take occurs. As such, these protocols are a streamlined version of the USFWS protocols, designed to minimize the potential for take while recognizing a point of diminishing return, that is, the conservation needs of the species are better met by focusing financial resources on mitigation of residual effects rather than efforts to further minimize take. Guidance and protocols as described in this document may be updated to be consistent with current USFWS guidelines, and such updates shall not constitute an amendment to the MSHCP.

1.1 MSHCP Lead Species Biologist

A person with demonstrated experience working with MSHCP Covered Species and their habitats, including conducting protocol surveys, locating desert tortoise sign and burrowing owl sign, burrow excavation, and oversight of wildlife fence installation. The DCP will develop a robust training program to ensure that MSHCP Lead and Assistant Species Biologists can satisfactorily carry out species-specific Avoidance and Minimization protocols. To lead desert tortoise work, an MSHCP Lead Species Biologist must also meet current USFWS standards for a desert tortoise Authorized Biologist.

1.2 MSHCP Assistant Species Biologist

A person with demonstrated experience working with MSHCP Covered Species and their habitats, including conducting protocol surveys, locating desert tortoise sign, burrow excavation, and oversight of tortoise fence installation. MSHCP Assistant Species Biologists are generally less experienced than MSHCP Lead Species Biologists and must be overseen by an MSHCP Lead Species Biologist when conducting clearance surveys or other activities approved under the MSHCP Amendment.

2.0 Desert Tortoise Survey

2.1 General Survey Guidance

1. Every effort shall be made to complete surveys within 1 month prior to initial ground-disturbing activities to prevent substantial re-migration of tortoises onto project sites.

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[1] *[USFWS] U.S. Fish and Wildlife Service. 2009. Desert Tortoise (Mojave Population) Field Manual: (*Gopherus agassizii*). Region 8, Sacramento, California.*

[2] *[USFWS] U.S. Fish and Wildlife Service. 2019. Clearance Survey Protocol for the Mojave Desert Tortoise. In: USFWS. 2020. Translocation of Mojave Desert Tortoises from Project Sites: Plan Development Guidance. USFWS, Las Vegas, Nevada.*

[3] *[USFWS] U.S. Fish and Wildlife Service. 2019. Preparing for Any Action that may Occur within the Range of the Mojave Desert Tortoise (*Gopherus agassizii*). October 8.*

2. One MSHCP Lead Species Biologist per clearance survey site shall be present to supervise MSHCP Assistant Species Biologists and oversee clearances.
3. Clearance surveys require a single pass with 100 percent coverage of the project area.
    a) Focus on locating all desert tortoises, both above and below ground
    b) Surveys shall involve walking transects less than or equal to 10 feet (3 meters) wide under typical conditions.
    c) Surveys may be conducted at any time of year (see 2.2).
    d) Surveys shall be conducted when air temperatures are below 95 degrees F (35 degrees C), with air temperature measured approximately 5 centimeters from the soil in an area of full sun but in the shade of the observer.
4. Any time a vehicle is parked, whether the engine is engaged or not, the ground around and under the vehicle shall be inspected for desert tortoise immediately prior to moving the vehicle.
5. Desert tortoises shall be collected and transported to a temporary holding facility that has been approved for such use by the USFWS.
6. Global Positioning System (GPS) data points for all burrows and tortoise locations shall be collected in accordance with current DCP data management guidelines. All data shall be entered on the USFWS data sheet (Attachment 1) and reported back to the DCP.

2.2 Desert Tortoise Clearance

1. Desert tortoise clearances may occur year-round. All clearance activities (capture, transport, release, and related actions) shall occur when ambient temperatures are below 95 degrees F (35 degrees C) and are not anticipated to rise above 95 degrees F (35 degrees C) before handling and processing desert tortoises are completed.
2. All potential burrows with non-visible ends shall be scoped or hand-excavated to determine presence or absence of any protected species, including eggs. Excavation will be conducted using hand tools as described in Section 3.0.
    a) Any burrow occupied by a burrowing owl or other animal shall be left intact, unless burrowing owl procedures allow excavation to be conducted (see Appendix D).
3. All burrows confirmed unoccupied during clearance shall be collapsed or otherwise closed by the end of the survey to prevent re-occupation prior to ground disturbance.
4. Should a Gila monster be encountered, GPS data points of burrows, photographs, and the location of the Gila monster shall be collected in accordance with current DCP data management guidelines, and all data shall be reported to the Nevada Department of Wildlife (NDOW) at (702) 486-5127.
    a) If the Gila monster is exposed and there is potential for harm or injury, alert NDOW immediately. Should NDOW's response be delayed, MSHCP Lead Species Biologists or MSHCP Assistant Species Biologists should detain the Gila monster out of harm's way until NDOW arrive.
        i) Should NDOW not be immediately available to respond for photo-documentation, a digital camera (5 megapixel or higher) or 35mm camera will be used to take good-quality images of the Gila monster in situ at the location of live encounter or dead salvage. Images shall be provided to NDOW at reptiles@ndow.org along with specific location information including GPS coordinates (as described above), date, time, and habitat description. Photographs shall

show: (1) the encounter location (landscape with Gila monster in clear view); and if the Gila monster is dead or being salvaged, (2) a clear overhead shot of the entire body with a ruler next to it for scale (the Gila monster should fill the camera's field of view and be in sharp focus); (3) a clear, overhead close-up of the head (head should fill camera's field of view and be in sharp focus).[4]

5. Desert tortoises in burrows shall be removed by grasping and pulling, tapping, or careful excavation of the burrow.
   a) If the tortoise is within arm's reach, firmly grasp the gular, plastron, or posterior edge of the carapace and gently pull the tortoise toward the burrow entrance.
      i) If the tortoise resists to the point that moderate pulling is unsuccessful, stop pulling while maintaining a grip on the tortoise. Resume pulling when the tortoise relaxes.
      ii) Never use a hook or other instrument to remove a tortoise from a burrow.
   b) If the tortoise is visible but deep within the burrow, the observer shall remove the tortoise through careful excavation of the burrow following the protocols in Section 3.0.
6. Desert tortoises shall be collected and placed in a disinfected, clean container for transport following the protocols in this document.
   a) To minimize the risk of disease transmission (including Upper Respiratory Tract Disease, or URTD), tortoises shall be placed one to a container, even if they were found together or were occupying the same burrow.

3.0 Desert Tortoise Burrow Excavation

1. Excavators shall wear leather or cloth gloves during burrow excavation to avoid being bitten or stung by venomous animals. Excavators shall also wear N95 masks and eye protection to avoid potential exposure to Valley Fever fungal spores.
2. All potential burrows within the project site shall be excavated, except those occupied by venomous animals or large mammals such as kit fox or American badger. Burrows occupied by burrowing owl may be excavated only if the procedures in Appendix D allow for excavation.
   a) Spiderwebs, litter, and other debris may accumulate in burrow openings overnight, and openings may collapse during winter rains.
   b) Do not assume that a burrow is inactive if it looks unused or collapsed.
   c) If excavation is not possible with hand tools because of rock or sediment type, the burrow shall be scoped to the extent feasible to determine occupancy. If confirmed unoccupied, the entrance shall be closed to block reentry by desert tortoise and other wildlife. If the burrow cannot be confirmed unoccupied by desert tortoise, a motion sensor camera or other camera trap device suitable for detecting desert tortoise shall be installed to monitor the entrance for a minimum of 3 days. If no desert tortoise activity is detected at the burrow, the entrance shall be closed. If

[4] *[NDOW] Nevada Department of Wildlife. 2012. Gila Monster Status, Identification, and Reporting Protocol for Observations. Southern Region. September 7.*

desert tortoise is observed using and occupying the burrow, the Service shall be consulted regarding next steps, such as use of mechanized equipment to excavate the burrow.

3. Feel for desert tortoise eggs by gently probing the soil in front of the burrow opening with a blunt instrument and along the floor of the burrow as it is excavated.
   a) Areas of less compacted soil may indicate a nest.
   b) Eggs have been found up to 6 feet (1.9 meters) outside of the burrow opening and up to 6 feet (1.9 meters) within the burrow.
   c) Removal of the top 10 inches (25 centimeters) of soil (or until a hard soil layer is encountered) will typically ensure that all desert tortoise eggs, if present, will be detected.
   d) If eggs are detected, follow the methods in Section 5.0.
4. Blunt-nosed shovels or garden trowels shall be used for excavation.
   a) Place one shovel or garden trowel for small burrows in the burrow entrance and slice away the ceiling with a second shovel or trowel.
   b) Remove the loosened soil with the first shovel or trowel as excavation proceeds, and repeat.
5. The burrow shall be excavated slowly and carefully.
   a) Stop often to check whether a tortoise or eggs are within reach.
   b) Do not collapse the burrow interior ahead of the shovel or trowel.
6. Burrows shall be excavated an additional foot (0.3 meter) beyond the suspected end to ensure that a desert tortoise is not concealed behind a dirt plug or mound.
   a) All side tunnels within the burrow shall be searched for tortoises.
   b) If a tortoise is found, do not assume that it is alone.
   c) After removing the first tortoise encountered, return to the burrow and continue excavation to check for additional tortoises or eggs.

4.0 Desert Tortoise Handling

4.1 General Handling

1. Desert tortoises shall be handled in a manner that prevents overheating. Signs of overheating include aggressive struggling, animal being hot to the touch, frothing at the mouth, excessive salivation, and bladder voiding.
2. When handling desert tortoises, staff shall wear a new pair of disposable latex, nitrile, or rubber gloves, one pair, per tortoise, per encounter.
   a) If a glove is torn while handling a tortoise, (which is common, as a tortoise's toenail can scrape the glove), put a new glove on over the torn one.
   b) Once handling is complete, any skin that contacted the tortoise shall be disinfected with hand sanitizer.
   c) Used gloves and other disposable supplies (e.g., surveyor's tape or flagging) shall be placed in a plastic trash bag and disposed of offsite.

3. All tools that contact tortoises shall be disinfected after each use.

4.2 Hot Temperatures

1. Desert tortoises shall not be placed in any situation where they cannot maintain surface and core body temperatures necessary for their well-being.
2. Desert tortoises shall be kept shaded at all times until they are transported to the location of the former Desert Tortoise Conservation Center (DTCC) facility[2]. If a tortoise must be temporarily placed on the ground while shaded, remove the upper layer of hot substrate to expose a cooler layer beneath before setting the tortoise down. The transport destination may be updated by the USFWS.
    a) When possible, desert tortoises should not be captured if ground temperature is anticipated to exceed 95 degrees F (35 degrees C) before handling and transport can be completed.
    b) If the ground temperature exceeds 95 degrees F (35 degrees C) during handling, desert tortoises shall be kept shaded in an environment where ambient air temperature does not exceed 91 degrees F (32.7 degrees C) and ground temperature does not exceed 95 degrees F (35 degrees C).
    c) Desert tortoises that begin frothing at the mouth are likely approaching an upper lethal body temperature and shall be moved immediately to a climate-controlled environment. If no climate-controlled environment is nearby, the tortoise shall be placed immediately in an open, disinfected plastic container in the shade and shall have cool water poured over the shell to a depth sufficient to cool the animal while ensuring that the nares remain above water level.

4.3 Desert Tortoise Urination and Hydration

1. Desert tortoises may void their bladder when first encountered, picked up, or carried. Because desert tortoises store water in their bladders, any loss of this fluid may result in death.[5]
    a) Discourage bladder voiding by moving the tortoise gently and slowly. Avoid all unnecessary actions that may stress the animal.
    b) Bladder voiding may also be discouraged by pressing the tortoise's tail against its vent while carrying it. Also, press the tail against the vent if the tortoise begins to urinate.
2. When weather records indicate that desert tortoises likely have not had an opportunity to drink within the previous or current active season, or when clinical signs suggest that a tortoise may be dehydrated, the tortoise shall be soaked to rehydrate it before transport to a temporary facility or in the case of direct translocation, before transport to the release location.
    a) Place the tortoise in an uncovered container or other suitable tub-like receptacle with the water level just below the tortoise's chin. Water temperature should be tepid to cool in warm months and tepid to slightly warm in cool months. Soak the tortoise for 15-30 minutes.
    b) The container holding the tortoise should be placed in the shade. In summer months, an air-conditioned vehicle may be used; in winter months, a vehicle maintained at approximately 55 degrees F may be used where conditions allow. Tortoises shall never be left unattended in a vehicle.

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[5] *Averill-Murray, R.C. 2002. Effects on survival of desert tortoises (Gopherus agassizii) urinating during handling. Chelonian Conservation and Biology 4: 430–435.*

c) If containers are reused, they shall be sterilized using a 10 percent bleach solution, or other approved disinfectants such as 1 percent Trifectant solution, before being used for a different tortoise.

5.0 Nest and Egg Handling Protocol

1. Any nest found shall be carefully excavated by hand at a time of day when the air temperature 6 inches (15 centimeters) above the ground is approximately equal to the soil temperature at egg level.
2. Excavate suspected nests by hand.
   a) Disposable rubber or latex gloves shall be worn when marking and handling eggs.
3. Before any nest contents are disturbed, each egg shall be marked with a small dot on top using a felt-tipped pen to establish and maintain the egg's orientation.
   a) Eggs must be maintained in this orientation at all times.
4. Extra care shall be taken from August through October, as eggshells become extremely fragile during this period.
   a) Broken eggs shall be buried nearby and left in the field, or, if approved, their contents preserved for research projects.
   b) All broken eggs shall be reported on the data sheet (Attachment 1), and the DCP will report broken eggs to the USFWS.
5. Measure and record the depth of the nest below the soil surface and the position of the nest relative to the burrow entrance (or other shelter).
6. Place approximately 1 inch (2.5 centimeters) of soil from the nest area in a bucket and carefully transfer the eggs to the bucket, keeping the eggs in correct orientation.
   a) Gently cover the eggs with soil free of cobbles and pebbles, to a depth equivalent to that of the original nest.
7. Transport the eggs to the former DTCC facility; the DCP will coordinate transfer to the Service-approved relocation site.

6.0 Desert Tortoise Transport

1. During transport each tortoise shall remain in a clean, unused container that is covered or closed.
   a) Absorbent material such as newspaper or hay may be placed in the bottom of the container to absorb any voided urine, particularly when transport is expected to be prolonged.
   b) The container shall be ventilated in a manner that prevents a tortoise's leg or head from becoming stuck.
   c) Desert tortoises shall not be allowed to roam freely in the vehicle.
2. If containers are reused, they shall be sterilized using 10 percent bleach solution, or other approved disinfectants such as a 1 percent Trifectant solution, before being used to transport other tortoises.
3. Tortoises shall not be placed over the catalytic converter or any other vehicle area that becomes hot during operation.

4. Tortoises shall never be left unattended in a vehicle.
5. During summer months, tortoises shall be transported in an air-conditioned vehicle.
6. During the winter inactivity period, tortoises shall be transported in a vehicle kept as close to approximately 55 degrees F as ambient conditions allow, to support a physiological state similar to hibernation. The vehicle interior should not be warmed substantially above outside winter temperatures.
7. Tortoises shall never be transported in the bed of a truck.

7.0 Desert Tortoise Disposition

1. Desert tortoises found during clearance surveys will be transported to the location of the former DTCC facility or directly to a Service-approved translocation site.
    a) Tortoises shall be transported to the former DTCC facility or Service-approved translocation site on the same day as the survey and clearance.
        i) No tortoise shall be held by a surveyor overnight.
    b) Access to the former DTCC will be granted, but the surveyor must contact the DCP at least 24 hours prior to clearance to allow time for intake preparation.
    c) Tortoises shall be dropped off at the former DTCC facility, where the surveyor will meet DCP staff for transfer of the tortoises.
        i) Surveyors using personal reusable containers shall collect those containers no earlier than 48 hours, and no later than 120 hours after drop off. Containers must be clearly marked by the owner to be eligible for collection. The DCP may also provide surveyors with cardboard boxes upon request.
        ii) Upon picking up personal containers for reuse, the surveyor is responsible for cleaning and disinfecting them. Surveyors will have access to water at the former DTCC to rinse containers. Access to the facility is granted only for retrieving containers that were used to drop off desert tortoises at the former DTCC, and only at the time of container pickup.
        iii) Following drop-off, the DCP will coordinate desert tortoise health assessments and translocation to Service-approved relocation sites.
    d) If a new facility is approved for temporary desert tortoise holding, these protocols will be updated to reflect the current location, and the DCP will provide notice to MSHCP Lead Species Biologists conducting clearance surveyor.

Attachment 1. Desert Tortoise Clearance Survey Data Form

Date of survey:_____ (day, month, year) Survey biologist(s): _____ (name, email, and phone number)

Site description: _____ (project name and size; general location)

County:_____ Quad:_____ Location:_____ (UTM coordinates, lat-long, and/or TRS; map datum)

Circle one: 100% coverage or Sampling Area size to be surveyed:_____ Transect #:_____ Transect length: _____

GPS Start-point: _____ (easting, northing, elevation in meters) Start time:_____am/pm

GPS End-point: _____ (easting, northing, elevation in meters) End time:_____am/pm

Start Temp:_____ºC End Temp:_____ºC

Live Tortoises

Detection number	GPS location Easting	GPS location Northing	Time	Tortoise location (*in burrow*: all of tortoise beneath plane of burrow opening, or *not in burrow*)	Approx MCL ≥180 mm? (*Yes, No or Unknown*)	Existing tag # and color, if present
1						
2						
3						
4						
5						
6						
7						
8						

Tortoise Sign (burrows, scats, carcasses, etc.)

Detection number	GPS location Easting	GPS location Northing	Type of sign (*burrows, scats, carcass, etc*)	Description and comments
1				
2				
3				
4				
5				
6				
7				
8				

Tortoise Nests/Eggs

Detection number	GPS location Easting	Northing	Distance of Nest from Burrow/Cover Entrance	Depth of nest	Description and comments
1					
2					
3					
4					
5					
6					
7					
8					

Appendix D

Burrowing Owl Clearance Survey Protocol

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Attachment 1 – Burrowing Owl Clearance Survey Protocol

1.0 Qualified Biologist Definition

As described in Section 6.3.3.2 of the MSHCP Amendment, the following terms and definitions will be used to determine qualified biologists to conduct burrowing owl clearance surveys and exclusions. Survey and clearance guidance is based on the California Department of Fish and Wildlife Staff Report on Burrowing Owl Mitigation because no published standard guidance specific to Mojave Desert populations is currently available. Guidance and protocols as described in this document may be updated to be consistent with current guidelines, and such updates shall not constitute an amendment to the MSHCP.

1.1 MSHCP Lead Species Biologist

A person with demonstrated experience working with MSHCP Covered Species and their habitats, including conducting protocol surveys, locating desert tortoise and burrowing owl sign, burrow excavation, and oversight of wildlife fence installation. The DCP will develop a robust training program to ensure that MSHCP Lead and Assistant Species Biologists can satisfactorily carry out species-specific Avoidance and Minimization protocols.

1.2 MSHCP Assistant Species Biologist

A person with demonstrated experience working with MSHCP Covered Species and their habitats, including conducting protocol surveys, locating desert tortoise and burrowing owl sign, burrow excavation, and oversight of tortoise fence installation. MSHCP Assistant Species Biologists are generally less experienced than MSHCP Lead Species Biologists and must be overseen by an MSHCP Lead Species Biologist when conducting clearance surveys or other activities approved under the MSHCP Amendment.

2.0 Burrowing Owl Survey

2.1 General Survey Guidance

1. Every effort shall be made to complete surveys within 1 month prior to initial ground-disturbing activities to prevent substantial re-migration of burrowing owls onto project sites.
2. One MSHCP Lead Species Biologist per clearance survey site shall be present to supervise MSHCP Assistant Species Biologists and oversee clearances.
3. Clearance surveys require a single pass with 100 percent coverage of the project area.
    a) Focus on locating all burrowing owls residing in the project area, both above and below ground.
    b) Surveys shall involve walking transects spaced as follows:
        i) Less than or equal to 10 feet (3 meters) wide under typical conditions when in desert tortoise potential habitat and desert tortoise clearance surveys are being conducted simultaneously; or
        ii) Between 23 feet and 65 feet (7 meters to 20 meters) apart when outside of desert tortoise potential habitat, adjusting for vegetation height and density. Transect spacing shall not exceed 65 feet (20 meters), and exact spacing shall be determined by the distance at which 100 percent visualization of ground and burrows is achieved.
    c) While walking transects:

i) Surveyors shall scan the entire visible project area for burrowing owls using binoculars at the start of each transect and at least every 330 feet (100 meters) thereafter, to minimize missing flushed owls.
ii) Surveyors shall scan areas to the left and right of the transect line up to the halfway point to the next transect line. Scans shall focus on burrowing owl sign.

d) Clearance surveys should be conducted during the non-breeding season (September 1 through January 31), to the extent feasible, to avoid encountering breeding owls; however, clearance surveys may be conducted at any time of year (see Section 2.2).
e) Surveys should be conducted when burrowing owls are most active above ground. Optimal time of day varies based on weather, latitude, and season. Typically, surveys conducted between morning civil twilight and 10:00 AM (potentially earlier on hot summer days) and from two hours before sunset until evening civil twilight provide the highest detection probabilities.[1]
f) When in desert tortoise habitat, surveys should also be conducted when desert tortoises are most active, when feasible. Desert tortoises are typically most active:

i) During April and May, or September and October; and
ii) When air temperatures are below 95 degrees F (35 degrees C), with air temperature measured approximately 5 centimeters from the soil in an area of full sun but in the shade of the observer.

4. Any time a vehicle is parked, whether the engine is engaged or not, the ground around and under the vehicle shall be inspected for desert tortoise immediately prior to moving the vehicle.
5. If a desert tortoise is observed, desert tortoise protocols (MSHCP Appendix C) shall be implemented for capture and translocation.
6. Global Positioning System (GPS) data points for all burrows and burrowing owl observations shall be collected in Universal Transverse Mercator (UTM) Zone 11 North American Datum 1983 (NAD83). All data shall be entered on the data sheet (Attachment 1) and reported back to the DCP.

a) If subsequent surveys of the same site are conducted (for example, due to project delays), burrowing owl sign documented during a previous survey shall be removed after the location is recorded, so that any sign discovered during a subsequent survey can be identified as new. This applies even when associated burrows have been collapsed.

2.2 Burrowing Owl Clearance

1. Burrowing owl clearances may occur year-round, but are preferably conducted during the non-breeding season (as described in Section 2.1) because burrow collapse cannot be conducted if burrowing owls are confirmed to exhibit active nesting behavior. To the extent feasible, all clearance activities, including burrow excavation, shall occur when ambient temperatures are below 95 degrees F (35 degrees C) and are not anticipated to rise above 95 degrees F (35 degrees C) during the activity, to limit exposure of evicted owls to extreme temperatures. Where the survey area overlaps desert tortoise potential habitat, this temperature threshold also serves to protect any tortoises that may be encountered.

[1] *[CDFW] California Department of Fish and Wildlife, formerly California Department of Fish and Game (CDFG). 2012. Staff report on burrowing owl mitigation. Unpublished report. Sacramento, California, USA.*

2. Any burrow more than 4 inches (11 centimeters) in diameter (height and width) and more than 60 inches (150 centimeters) deep, or any burrow displaying burrowing owl sign such as feathers, whitewash, eggshells, pellets, or bones at the entrance, shall be investigated with an appropriately bright light and a mirror, or scoped.

    a) Any burrow occupied by a burrowing owl shall be left intact and marked for passive relocation (Section 2.3).

    b) Burrows with visible backs determined to be unoccupied may be collapsed on the survey line following the protocol in Section 3.0. Surveyors should record any sign present but then remove it from the area so it does not confuse future surveyors.

    c) If occupancy is inconclusive, see Section 2.3.2. Where appropriate, excavation will be conducted using hand tools as described in Section 3.0.

    d) Burrows with non-visible ends shall be scoped to determine presence or absence of any protected species and their eggs or young. Any burrow occupied by a desert tortoise shall be handled per protocols in MSHCP Appendix C. Any other animals shall be left intact.

3. Should a Gila monster be encountered, GPS data points of burrows, photographs, and the location of the Gila monster shall be collected in UTM Zone 11 NAD83. All data shall be reported to the Nevada Department of Wildlife (NDOW) at (702) 486-5127.

    a) If the Gila monster is exposed and there is potential for harm or injury, alert NDOW immediately. Should NDOW's response be delayed, MSHCP Lead Species Biologists or MSHCP Assistant Species Biologists should detain the Gila monster out of harm's way until NDOW personnel arrive.

        i) Should NDOW not be immediately available to respond for photo-documentation, a digital (5 megapixel or higher) or 35mm camera will be used to take good quality images of the Gila monster in situ at the location of live encounter or dead salvage. The pictures will be provided to NDOW at reptiles@ndow.org along with specific location information including GPS coordinates (as described above), date, time, and habitat description. Pictures will show the following information: (1) Encounter location (landscape with Gila monster in clear view); and if Gila monster is dead/salvage, (2) a clear overhead shot of the entire body with a ruler next to it for scale (Gila monster should fill camera's field of view and be in sharp focus); (3) a clear, overhead close-up of the head (head should fill camera's field of view and be in sharp focus).[2]

4. If a burrowing owl is observed flushing from the area, estimate the site location, mark it with flagging, and record the location with GPS.

2.3 Nest Avoidance and Passive Relocation of Non-Breeding Owls

1. Breeding season. Occupied burrowing owl burrows during the breeding season that are determined to contain a breeding pair shall be clearly marked and given a 330-foot (100-meter) buffer zone from construction activities, including but not limited to excessive dust, noise, and vibrations. If an occupied burrow is determined to contain a non-breeding owl, then passive relocation of the burrowing owl may occur within the breeding season following the methods in Section 2.3.2.

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[2] [NDOW] Nevada Department of Wildlife. 2012. Gila Monster Status, Identification, and Reporting Protocol for Observations. Southern Region. September 7.

a) This buffer zone must be clearly communicated to all construction crews on site and shall remain in effect until owlets have completely fledged or the nest is otherwise determined inactive by an MSHCP Lead Species Biologist.

i) Fledging will be determined by time of year (typically no earlier than August 31). Once fledging or nest inactivity (failure) is suspected, the burrow must be confirmed empty by scoping it daily for seven consecutive days. Once confirmed empty, the burrow may be collapsed even if still within the breeding season, following the guidelines in Section 3.0. If burrowing owls are still occupying the burrow but fledging has been determined, then passive relocation may occur following the methods in Section 2.3.2.

2. Passive relocation. At any time of year, non-breeding burrowing owls may be passively relocated as described below. Passive relocation is intended to assist the burrowing owl in self-relocating to other burrows outside of the project area, which may reduce the likelihood that the owl attempts to re-occupy the project area. The location of each occupied burrow shall be recorded and documented.

a) A one-way door shall be installed in the neck of the burrow to prevent an owl from re-entering once it leaves. A one-way door shall also be installed at burrows with inconclusive occupancy as described in Section 2.2.2.c.

b) Do not assume that the bird has left, and do not assume that the one-way door has worked correctly. The burrow must be confirmed empty by scoping on two consecutive days. Where time constraints make consecutive-day scoping infeasible, the burrow may instead be confirmed empty by independent scoping by two biologists on the same day; at least one of the two must be an MSHCP Lead Species Biologist, and the second may be either an MSHCP Lead Species Biologist or an MSHCP Assistant Species Biologist. Once vacancy is confirmed, the burrow may be collapsed as described in Section 3.0.

c) If a one-way door cannot be used, a motion-sensor camera or other camera trap device suitable for detecting burrowing owl must be placed at the burrow mouth for a minimum of 3 days. The burrow must then be scoped to confirm vacancy before burrow excavation, which shall follow the guidelines in Section 3.0.

3.0 Burrowing Owl Burrow Excavation

Burrow excavation shall follow the guidelines for desert tortoise burrow excavation (MSHCP Appendix C, Section 3.0), which are repeated here for convenience. Before excavation, all burrows shall have been inspected for desert tortoise and tortoise eggs as described in MSHCP Appendix C and confirmed vacant of burrowing owl as described above in Section 2.0. If a desert tortoise or tortoise eggs are encountered, follow the protocols for handling and transport of desert tortoise as described in MSHCP Appendix C. All burrows confirmed unoccupied during clearance shall be collapsed or otherwise closed by the end of the survey to prevent re-occupation prior to ground disturbance.

1. Excavators shall wear leather or cloth gloves during burrow excavation to avoid being bitten or stung by venomous animals. Excavators shall also wear N95 masks and eye protection to avoid potential exposure to Valley Fever fungal spores.
2. If a burrowing owl or burrowing owl nest is encountered during excavation, stop and restart the process at the protocols outlined in Section 2.3.
3. All potential burrows within the project site shall be excavated, except those occupied by venomous animals or large mammals such as kit fox or American badger.

a) Spider webs, litter, and other debris may accumulate in burrow openings overnight, and openings may collapse during winter rains.

b) Do not assume that a burrow is inactive if it looks unused or collapsed.

c) If excavation is not possible with hand tools because of rock or sediment type, the burrow shall be scoped to the extent feasible to determine occupancy. If confirmed unoccupied, the entrance shall be closed to block reentry by desert tortoise, burrowing owl, and other wildlife. If the burrow cannot be confirmed unoccupied by desert tortoise or burrowing owl, a motion-sensor camera or other camera trap device suitable for detecting both species shall be installed to monitor the entrance for a minimum of 3 days. If no desert tortoise or burrowing owl activity is detected, the entrance shall be closed. If desert tortoise or burrowing owl is observed using and occupying the burrow, the Service shall be consulted regarding next steps, such as use of mechanized equipment to excavate the burrow.

4. Feel for desert tortoise eggs by gently probing the soil in front of the burrow opening with a blunt instrument and along the floor of the burrow as it is excavated.

   a) Areas of less compacted soil may indicate a nest.

   b) Desert tortoise eggs have been found up to 6 feet (1.9 meters) outside of the burrow opening and up to 6 feet (1.9 meters) within the burrow.

   c) Removal of the top 10 inches (25 centimeters) of soil (or until a hard soil layer is encountered) will typically ensure that all desert tortoise eggs, if present, will be detected.

   d) If eggs are detected, follow the methods in MSHCP Appendix C, Section 5.

5. Blunt-nosed shovels or garden trowels shall be used for excavation.

   a) Place one shovel (or garden trowel for small burrows) in the burrow entrance and slice away the ceiling with a second shovel or trowel.

   b) Remove the loosened soil with the first shovel or trowel as excavation proceeds, and repeat.

6. The burrow shall be excavated slowly and carefully.

   a) Stop often to see if a tortoise or eggs are within reach.

   b) Do not collapse the burrow interior ahead of the shovel or trowel.

7. Burrows shall be excavated an additional foot (0.3 meter) beyond the suspected end to ensure that a desert tortoise is not concealed behind a dirt plug or mound.

   a) All side tunnels within the burrow shall be searched for tortoises.

   b) If a tortoise is found, do not assume that it is alone.

   c) After removing the first tortoise encountered, return to the burrow and continue excavation to check for additional tortoises or eggs.

Attachment 1. Burrowing Owl Clearance Survey Data Form

Date of survey:_____ (day, month, year) Survey biologist(s): _____ (name, email, and phone number)

Site description: _____ (project name and size; general location)

County:_____ Quad:_____ Location:_____ (UTM coordinates, lat-long, and/or TRS; map datum)

Circle one: 100% coverage or Sampling Area size to be surveyed:_____ Transect #:_____ Transect length: _____

GPS Start-point: _____ (easting, northing, elevation in meters)

GPS End-point: _____ (easting, northing, elevation in meters)

Start time:_____am/pm

Start Temp:_____ºC End Temp:_____ºC

End time:_____am/pm

Burrowing Owl

Detection number	GPS location Easting	GPS location Northing	Time	Burrowing owl location (*in burrow*, or *not inburrow*)	Adult or Juvenile
1					
2					
3					
4					
5					
6					
7					
8					

Burrowing Owl Sign (burrows, pellets, whitewash, bones, etc)

Detection number	GPS location Easting	GPS location Northing	Type of sign (*burrows, pellets, whitewash, etc*)	Description and comments
1				
2				
3				
4				
5				
6				
7				
8				

Burrowing Owl Nests

Detection number	GPS location Easting	Northing	Nest Stage (incubation, owlets)	Description and comments
1				
2				
3				
4				
5				
6				
7				
8				

Appendix E

Boulder City Conservation Easement Management Plan (2023)

CLARK COUNTY MULTIPLE SPECIES HABITAT CONSERVATION PLAN

BOULDER CITY CONSERVATION EASEMENT MANAGEMENT PLAN

Version 3.6

March 2023

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Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
ACEC	Area of Critical Environmental Concern
AFY	acre-feet per year
AMMP	Adaptive Management and Monitoring Plan
BCCE	Boulder City Conservation Easement
BGO	Biological Goals and Objectives
BLM	Bureau of Land Management
City	City of Boulder City
DCP	Desert Conservation Program
MSHCP	Multiple Species Habitat Conservation Plan
NCA	National Conservation Area
NDOT	Nevada Department of Transportation
NDOW	Nevada Department of Wildlife
NPS	National Park Service
OHV	off-highway vehicle
Permittees	Clark County, the cities of Las Vegas, North Las Vegas, Mesquite, Henderson, and Boulder City, and the Nevada Department of Transportation
RMP	Resource Management Plan
SR	State Route
US 95	U.S. Highway 95
USFWS	U.S. Fish and Wildlife Service

Executive Summary

This Boulder City Conservation Easement (BCCE) management plan (Plan) identifies actions for managing the BCCE , a unit of the Clark County reserve system under the Multiple Species Habitat Conservation Plan (MSHCP). This plan serves as a reference for the ongoing management activities to preserve, protect, maintain, and enhance the natural resource values of the BCCE. The development of this Plan for the BCCE meets the intent of Condition P of the Section 10(a)(1)(B) incidental take permit, which is to ensure that uses of the BCCE are consistent with protection and management of the desert tortoise and its habitat (USFWS 2001).

The BCCE is located in the northeastern Mojave Desert within the Eldorado Valley in southeastern Clark County, Nevada. The 87,310-acre reserve unit is south of Boulder City, approximately 4 miles south of the intersection of U.S. Highways 95 (US 95) and 93. Primary purpose of the reserve unit is to protect and manage desert tortoise and its habitat.

This Plan describes the background of the MSHCP and history of the easement and provides detailed descriptions of the reserve unit including physical, biological, water, and cultural resources; land uses; and stressors to natural resources.

Program-wide biological goals and objectives (BGOs, Alta 2016, 2023) are a condition of the MSHCP, which guide monitoring and inform adaptive management. The management goals, objectives, and actions outlined in the Plan are specific to the BCCE. These Plan goals and objectives are guided by and overlap with the program-wide BGOs. The management goals, listed below, are broad, general statements that establish the management direction of the BCCE, whereas the management objectives provide as specific direction as related to achieving the management goals. The Plan includes management actions to meet the management objectives and to achieve goals. Each management action is linked to effectiveness measures that are reported on quarterly, at a minimum..

BCCE Management Goals and Objectives

Goal 1	**Protect and manage the BCCE for the desert tortoise and its habitat.**
Objectives	*1.0 Restore and enhance desert tortoise habitat and monitor desert tortoise populations on the BCCE.*
	2.0 Install and maintain infrastructure that controls tortoise movement.
	3.0 Identify and decrease direct stressors to desert tortoise, as needed.
Goal 2*	**Protect and manage the BCCE for other MSHCP-covered species.**
Goal 3	**Manage the property and public uses to meet conservation obligations and legal requirements.**
Objectives	*4.0 Promote a road network that supports conservation and provides appropriate access for management and public use.*
	5.0 Provide law enforcement.
	6.0 Control invasive plant species and noxious weeds.
	7.0 Promote responsible recreation and inform the public on current activities.
	8.0 Manage allowable uses.
	9.0 Manage prohibited uses (Appendix C).
** There are no current specific management objectives for this goal because the BCCE is protected and managed for the desert tortoise. As concepts from the Adaptive Management and Monitoring Plan (AMMP, Alta, 2023) are further integrated into BCCE Management Plan, specific objectives for this goal will be developed.*	

Summary of Updates for Each Version

Version	Summary of Updates
3.3 (2017)	• Added discussion on ecological resilience and its relationship to ecological stressors (Section 2.4.3) • Incorporation of the 2016 Biological Goals and Objectives (BGOs) in the Appendix E table (Management and effectiveness measures) • Added specific expansion criteria (Section 2.1)
3.4 (2019)	• Added Appendix D, Vegetation Inventory. This addition displaced previous Appendix D (Contact Information; Now is Appendix E) and previous Appendix E (Management Actions; Now is Appendix F). • Updated information in the Desert Tortoise (sub-section of 2.4.2), Ecological Resilience (Section 2.4.3), and Predation (a sub-section of 2.4.3) sections to reflect updated studies and information.
3.5 (2021)	• Added BCCE boundary adjustment information from the 2020 easement amendment (Section 2, Figure 2). • Moved select information from the body of the document to appendices to improve overall readability (BCCE expansion and exchange criteria in Appendix B, and soil type descriptions in Appendix E). • Minor restructuring of format (table of contents) to more closely align with the Riparian Management Plan • Added clarifying language to differentiate between the management goals and objectives in this management plan versus the Biological Goals and Objectives (Section 3). • Moved Management Actions table (previously Appendix F) into Section 3.3
3.6 (2023)	• Editorial updates throughout • Edited management actions to reflect regular, ongoing maintenance and monitoring activities at the BCCE. • Updated maps, references

Section 1 Introduction

The Clark County Desert Conservation Program (DCP) manages Endangered Species Act compliance on behalf of Clark County and the cities of Boulder City, Henderson, Las Vegas, North Las Vegas, Mesquite, and the Nevada Department of Transportation (collectively, the Permittees) through implementation of the Clark County Multiple Species Habitat Conservation Plan (MSHCP) and associated Section 10(a)(1)(B) incidental take permit. The incidental take permit required that the Permittees establish a conservation easement in the Eldorado Valley to be managed and protected for the benefit of the desert tortoise (*Gopherus agassizii*) as partial mitigation for the take of desert tortoise and its habitat. The Boulder City Conservation Easement (BCCE) was established by agreement between the County and Boulder City in July of 1995 to fulfill this requirement of the incidental take permit.

The management goal prescribed for the BCCE is to ensure that the property is retained in a natural condition and to prevent any uses that would impair the conservation, protection, restoration, and enhancement of the natural resource values, especially those values associated with habitat for the desert tortoise and other indigenous flora and fauna. The development of this Plan for the BCCE meets the intent of Condition P of the incidental take permit (U.S. Fish and Wildlife Service [USFWS] 2001), which is to ensure that uses of the BCCE are consistent with protection and management of the desert tortoise and its habitat. The purpose of this Plan is to identify actions in a manner to preserve, protect, maintain, and enhance natural resource values of the property, primarily for the desert tortoise but also for other indigenous flora and fauna. This Plan links management actions (Section 3.2) to the management goals and objectives developed for the BCCE (Section 3.1), and establishes overall management direction and clarifies management responsibilities (Section 1.4). It serves as a guide to provide background and context, describe regular ongoing activities, and define future discretionary actions to manage public uses and achieve desired habitat conditions for the desert tortoise and other species covered by the MSHCP. Implementation of the many management actions will be detailed in separate restoration or project plans.

1.1 History of the BCCE

In 1958, Congress authorized the Secretary of the Interior to convey up to 126,775 acres of Bureau of Land Management (BLM) land in the Eldorado Valley to the Colorado River Commission, an agency of the State of Nevada. The Colorado River Commission requested in 1968 the conveyance of 107,412 acres from the BLM, referred to as the Eldorado Valley Transfer Area. In 1990, Boulder City (City) proposed to purchase the Eldorado Valley Transfer Area from the Colorado River Commission to manage as a buffer against development that might not meet the City's limited growth ordinance. The Secretary of the Interior eventually signed a Contract of Sale and Land Patent (deed) that conveyed the Eldorado Valley Transfer Area to the Colorado River Commission in July 1995. The Colorado River Commission subsequently transferred the deed to the City. The deed stipulated that the Eldorado Valley Transfer Area was to be used for desert tortoise conservation, public recreation, and a solar power peaking station. The Colorado River Commission also stipulated that the deed was subject to valid existing rights, including rights-of-way, reservations, restrictions, covenants, easements, and conditions of record described in the contract.

Under the Desert Conservation Plan (predecessor to the MSHCP) and associated Section 10 incidental take permit (Clark County 1994; USFWS 1995), the Permittees were required to establish an approximately 85,000-acre conservation easement in the Eldorado Valley Transfer Area that would be managed and protected for the benefit of the desert tortoise as partial

mitigation for take of the tortoise and its habitat. During the development of the Desert Conservation Plan, the City and County signed the Interlocal Agreement for Sale and Grant of a Conservation Easement in July 1994, which stipulated that the City would grant a conservation easement to the County once the land was acquired from the Colorado River Commission. Amendments to the easement occurred in 2010 and 2020 (Appendix A). The BCCE was thereby established on 87,310 acres of land by a Conservation Easement Grant (Hereafter 'Grant') from the City to the County in July 1995. Condition 7 of the Section 10 incidental take permit associated with the Desert Conservation Plan stated:

> Upon purchase of lands under the Eldorado Valley Transfer Act, Boulder City shall convey a conservation easement affecting 85,000 acres to an entity designated by the County, which will guarantee that those lands will be managed and protected for the benefit of the tortoise. Boulder City shall be responsible for supervising and regulating the activities which it authorizes or permits within the area in a fashion consistent with this Permit and the terms of the [Clark County Desert Conservation Plan]. Boulder City will annex those lands and adopt an ordinance which will incorporate the terms of the conservation easement to make it illegal to carry out any activity prescribed by the conservation easement as incorporated in the ordinance. Boulder City and the County will contract to provide law enforcement services to enforce the terms of the conservation easement and the ordinance.

The Section 10 incidental take permit associated with the MSHCP (USFWS 2001) included the requirement to maintain the BCCE as a conservation reserve for covered species. Condition P of that Section 10 permit stated:

> The Permittees shall ensure that any future development or use of the 85,000-acre conservation easement be consistent with the goals outlined in the [Desert Conservation Plan] which are to protect and manage the desert tortoise and its habitat. Furthermore, the Permittees shall take measures necessary to ensure maintenance in perpetuity, of connectivity for desert tortoise and other Covered Species, within the Boulder City Conservation Easement, including an adequate North-South corridor for the desert tortoise, as determined by the [adaptive management program].

1.2 Guiding Documents

The primary guiding documents for the MSHCP include:

- MSHCP and Environmental Impact Statement (Clark County 2000a)
- Incidental Take Permit No. TE034927-0 (USFWS 2001)
- MSHCP Implementing Agreement (Clark County 2000b)
- Biological and Conference Opinion (USFWS 2000)

These documents are available electronically at:

https://www.clarkcountynv.gov/government/departments/environment_and_sustainability/desert_conservation_program/guiding_documents.php

In addition to these guiding documents, the management of the BCCE is governed by a series of specific documents executed between Clark County, on behalf of the Permittees, Boulder City, and the U.S. Fish and Wildlife Service. These documents include:

- Interlocal Agreement for Sale and Grant of a Conservation Easement (July 1994).

- Amendment to the Conservation Easement Grant by and between the City of Boulder City and the County of Clark, Nevada also known as the Boulder City Conservation Easement (August 2010).

The Amendment to the Conservation Easement Grant revised and added language and exhibits to the 1995 Grant that clarified locations of rights-of-way, provided guidelines and requirements for third party projects to restore and mitigate surface disturbances, and identified locations for treated wastewater effluent discharge. These documents are available on the DCP website:

https://www.clarkcountynv.gov/government/departments/environment_and_sustainability/desert_conservation_program/bcce.php

1.3 Applicable Regulations

Certain federal, state, and local regulations also apply to actions that occur within the BCCE. Boulder City Code, Title 7, Chapter 5 (7-5-8) lists prohibited activities, with exceptions to these activities that can occur on the easement with appropriate permission from the City, County, and/or USFWS. Any restoration or conservation action that could adversely affect the flood capacity of the 100-year floodplain is subject to review and approval by the City to meet the requirements of the National Flood Insurance Program (Boulder City Code 11-40-3). Any restoration project that disturbs more than one acre is subject to the provisions of stormwater discharge controls under Section 402 of the Clean Water Act and requires compliance with the Construction Stormwater General Permit issued by the Nevada Division of Environmental Protection. Management actions that could affect BLM land would be subject to the Federal Land Policy and Management Act for applicable right-of-way authorization, which also triggers environmental and cultural assessments under the National Environmental Policy Act and National Historic Preservation Act.

1.4 Management Roles and Responsibilities

Clark County, a Permittee to the MSHCP, serves as the Plan Administrator of the MSHCP on behalf of the other Permittees. Clark County is also the grantee of the conservation easement. The City of Boulder City is also a Permittee to the MSHCP as well as the grantor of the conservation easement. The management of the easement is governed by an interlocal agreement between the City of Boulder City and Clark County executed in July 1994 (Appendix A). The easement agreement outlines the required management activities for the conservation of the desert tortoise, allowable and prohibited uses of the BCCE, rights of the grantor (Boulder City) and the grantee (Clark County), and other policies and procedures. In 2010, Boulder City and Clark County amended the BCCE agreement to address needed clarifications in Clark County's decision process as Plan Administrator of the MSHCP; Boulder City treated wastewater discharge onto the BCCE, requirements of third-party projects that take place in the BCCE, and provisions for law enforcement.

The Clark County Board of County Commissioners represents the County as the grantee of the BCCE with the City. The role of the Board of County Commissioners is to review and approve the budget and expenditure of funds by the DCP to manage the BCCE, and to review the DCP's selection of contractors, approve contract awards, and obligate funds for conservation projects.

The DCP acts on behalf of the Board of County Commissioners as the grantee of the BCCE and serves in the primary role of implementing management activities within the BCCE in accordance with the Grant and guiding documents of the MSHCP. The DCP is responsible for planning and implementing management actions for long-term maintenance of natural resource values of the BCCE for the benefit of the desert tortoise. The DCP is responsible for regularly

reviewing this Plan for any changes or additions to management goals, objectives, and actions for the BCCE, and to update priority and implementation status of management actions.

The City holds fee title to the land and is the grantor of the conservation easement grant to the County. The City has the responsibility to enact and enforce ordinances and regulations to restrict the use of the BCCE in accordance with the Grant, as amended, and provides peace officers with authority to patrol the BCCE as agreed with and funded by the DCP. The City maintains the right to permit exceptions to prohibited uses and permit specific activities listed in the Grant, including non-intrusive monitoring for desert tortoise, non-consumptive recreation, and surface disturbance associated with habitat improvements. The City is responsible for minimizing impacts to natural resource values of the BCCE for its use of the property for treated wastewater effluent discharge and for construction of utilities and transmission lines.

The role of the USFWS is to review the biennial budget for managing the BCCE and to approve activities that involve collection of biological data and habitat improvement projects for the benefit of desert tortoise. The USFWS is also responsible for reviewing and approving certain uses of the property, including construction, effluent discharge, and motorized vehicle activities.

1.5 Implementation Plan and Budget Process

The MSHCP provides guidance on developing biennial budgets for implementation. The DCP, as the MSHCP Administrator, is responsible for developing a biennial Implementation Plan and Budget that is responsive to key provisions outlined in the MSHCP. Although the process of developing the Implementation Plan and Budget has varied over the past biennia, the general steps of the budget development process are to determine available funding and to identify and recommend actions that further the purpose of the MSHCP. Certain actions that are stipulated by the Section 10 incidental take permit are considered required expenditures to maintain compliance and are therefore non-discretionary. These non-discretionary actions include administering and managing the MSCHP implementation, supporting the Adaptive Management Program, managing the BCCE, managing acquired properties and water rights, maintaining the tortoise fencing program along major roads, wild tortoise pick-up services, and the public information and education program. Other actions that further the goals and objectives of the MSHCP but are not directly specified in the incidental take permit are considered discretionary, such as scientific research projects and desert tortoise augmentation projects.

Management actions on the BCCE are primarily funded through Section 10 mitigation fees and from the proceeds of federal land sales under the Southern Nevada Public Lands Management Act. Other outside sources of funding for conservation actions could include private grants, donations of in-kind labor, and mitigation fees paid by third parties as part of their compliance with Section 7 of the Endangered Species Act. These third-party Section 7 mitigation fees are typically restricted to enhancement or restoration of desert tortoise habitat.

Section 2 Reserve Unit Description

The BCCE is located in the northeastern Mojave Desert within the Eldorado Valley, in southeastern Clark County, Nevada (Figure 1). The BCCE begins approximately 4 miles south of the intersection of U.S. Highway 95 (US 95) and US 93 and extends for approximately 22 miles along US 95. State Route (SR) 165 and Eldorado Valley Drive cross the BCCE to the east and west, respectively. The BCCE is within the city limits of Boulder City, approximately 2 miles south-southwest of the developed area of the City.

The BCCE consists of 87,310 acres that is split by US 95 into a North Section consisting of 39,114 acres, and a South Section consisting of 48,196 acres. Excluded from the South Section is the Energy Zone, an area of

4,213 acres designated by the City for energy development (

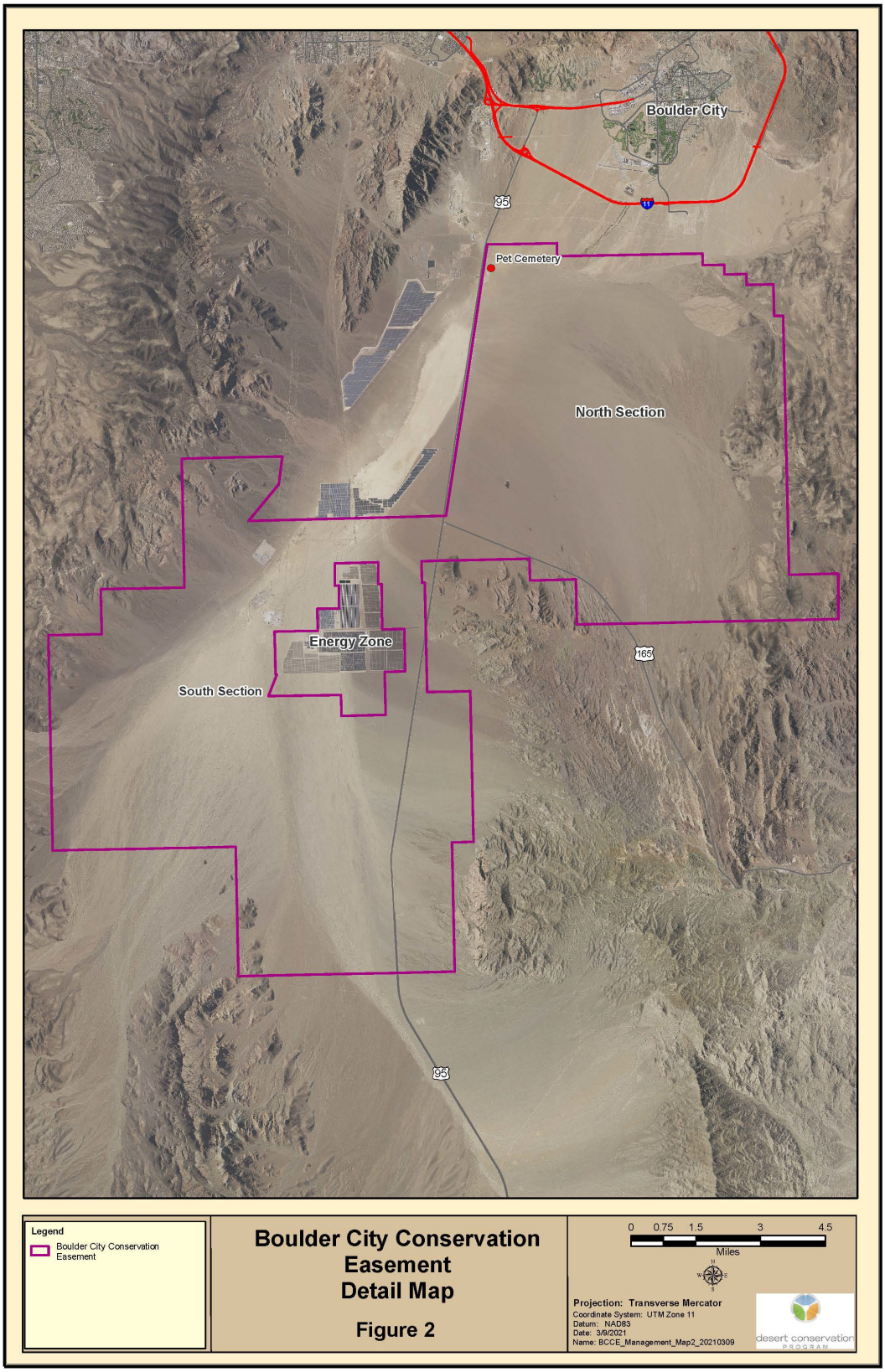


Figure 2). There was an Amended and Restated Easement Agreement grant completed in 2020 which resulted in a 1155-acre expansion of the energy zone within the BCCE; in exchange for 1927 acres of land

added to the northwest portion of the south section of the BCCE (

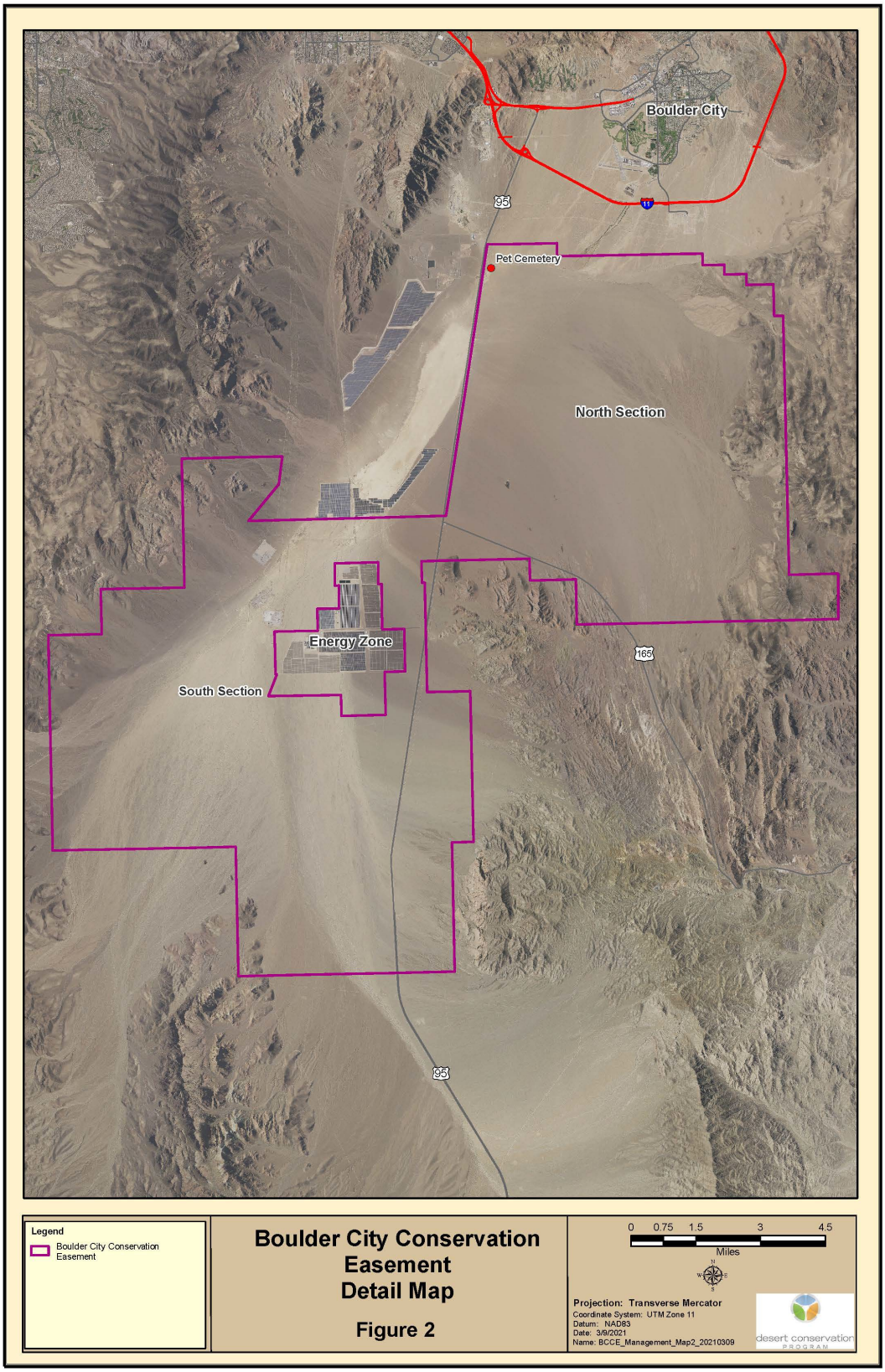


Figure 2). This agreement would allow for more solar to be built without the need for further fragmentation of the area while also adding a net increase of 772 acres to the easement boundary.

The legal description (section-township-range) of the BCCE is included as Exhibit A to Appendix A, the Conservation Easement Grant.

2.1 Expansion Criteria

Boulder City and DCP have considered and reviewed proposals to reconfigure or expand the Energy Zone. Land within the existing Energy Zone would be exchanged with the BCCE to expand the zone towards US 95. To date, these proposals for exchanges have not been approved.

Consideration for any future land expansion of the BCCE or land exchanges will consider several criteria that are described in Appendix B and listed in Table 1:

Table 1 Land Expansion and Exchange Criteria

BCCE Expansion Criteria
Undeveloped Habitat Suitable for Desert Tortoise
Contiguity with BCCE
Includes climate refugia habitat
BCCE Exchange Criteria
Quality of Desert Tortoise Habitat
Functional Size of Desert Tortoise Habitat
Review for the Presence of Other Covered Species
Equal or Lower Level of Habitat Fragmentation
Ease of Management
Equal or Greater Level of Habitat Protection
Evaluate Proposed Land Exchanges for Loss of Mitigation Actions
Evaluate the Proposed Land Exchange for Loss of Long-term Study Areas

2.2 Land Use

Land use includes land ownership, existing land use, land use plans, and zoning. Land use and land management practices can have a significant impact on natural resources, including water, soil, nutrients, plants, and animals.

2.2.1 Land Ownership

The BCCE is located on private lands within the jurisdictional limits of the City of Boulder City (Figure 3). Land to the north of the BCCE is also within Boulder City jurisdiction. Land to the east, west, and south is primarily under federal ownership and is managed by the BLM. The eastern edge of the North Section is adjacent to the Lake Mead National Recreation Area, administered by the National Park Service (NPS). Managed by BLM, Sloan Canyon National Conservation Area (NCA) is to the west of the BCCE and Piute-Eldorado Area of Critical Environmental Concern (ACEC) is to the south.

2.2.2 Historic, Existing, and Adjacent Land Use

Historical Land Use

Prior to conveyance of the Eldorado Valley Transfer Area to the Colorado River Commission and sale to the City, BLM managed the area for multiple uses, including energy transmission, telecommunications, mining, off-highway vehicle (OHV) racing, hunting, grazing, and open recreation. The most prominent use of the area before establishment of the easement was as an energy transmission hub.

A portion of the BCCE was also previously used for the establishment of a pet cemetery. The pet cemetery located in the northwest corner of the North Section of the easement has been in

existence since the 1960s (

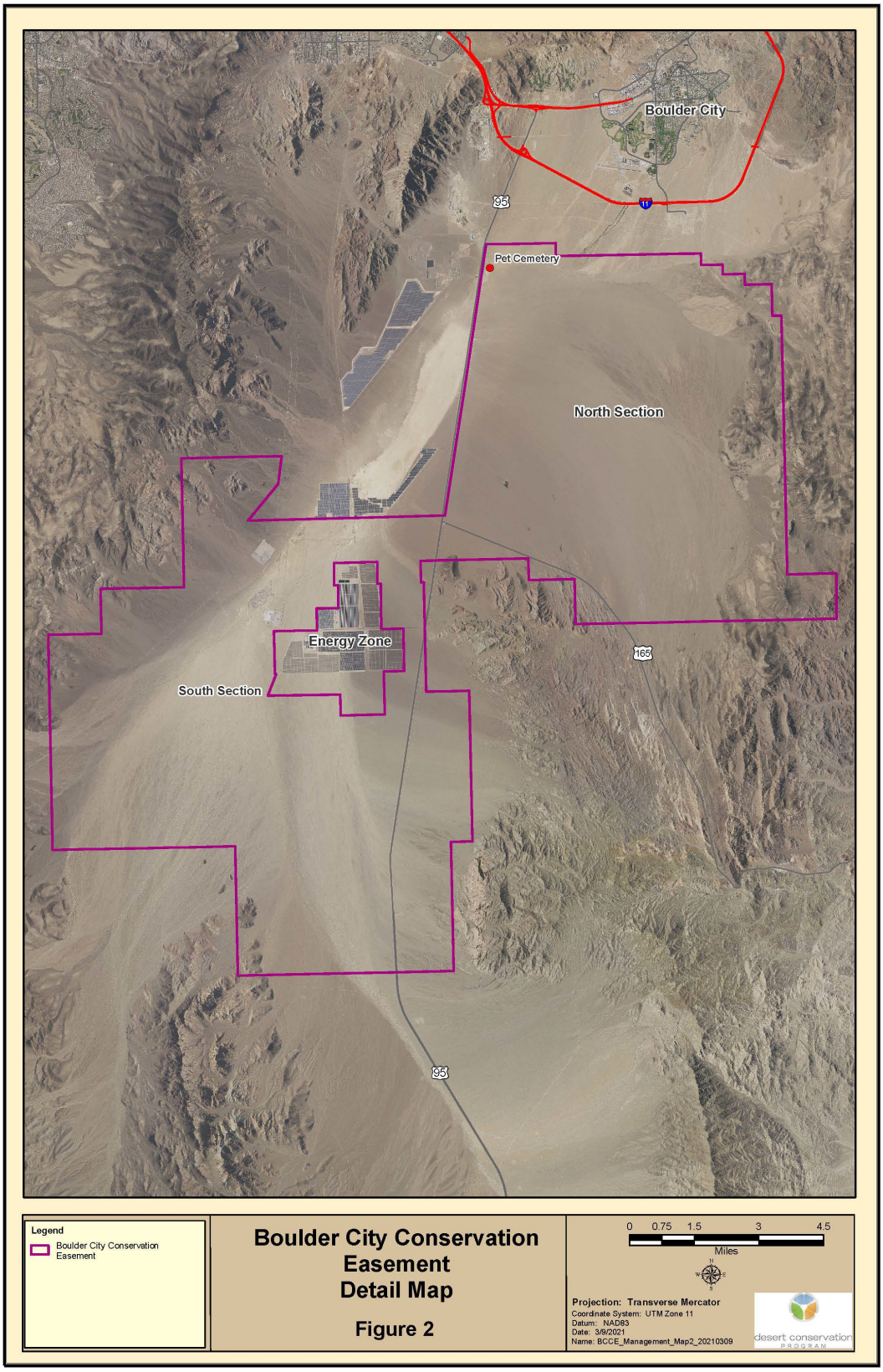


Figure 2). It was at one time authorized by the BLM under a Recreation and Public Purposes lease to the Humane Society of Southern Nevada; however, that lease expired in 1986. There were no BLM authorizations for animal burials reserved to the U.S. or transferred in the deed to the Colorado River Commission, and the City has never sanctioned the pet cemetery within the BCCE. Discarding dead animals on public property is prohibited as a nuisance by Boulder City Code 7-3-8. The pet cemetery covers approximately 14 acres with 1,600 graves. A three-wire post and cable barrier fence with a lockable gate was installed around the cemetery in 2013 to contain further encroachment into the easement.

Existing Land Use and Allowable Uses

The BCCE guiding documents limited historical uses to transmission of energy and telecommunications. Overhead transmission lines and access roads, primarily in a northeast-southwest direction, cross the easement (Figure 4). There are also three switching yards and substations located within the BCCE, shown in Figure 4 and as listed in Table 2.

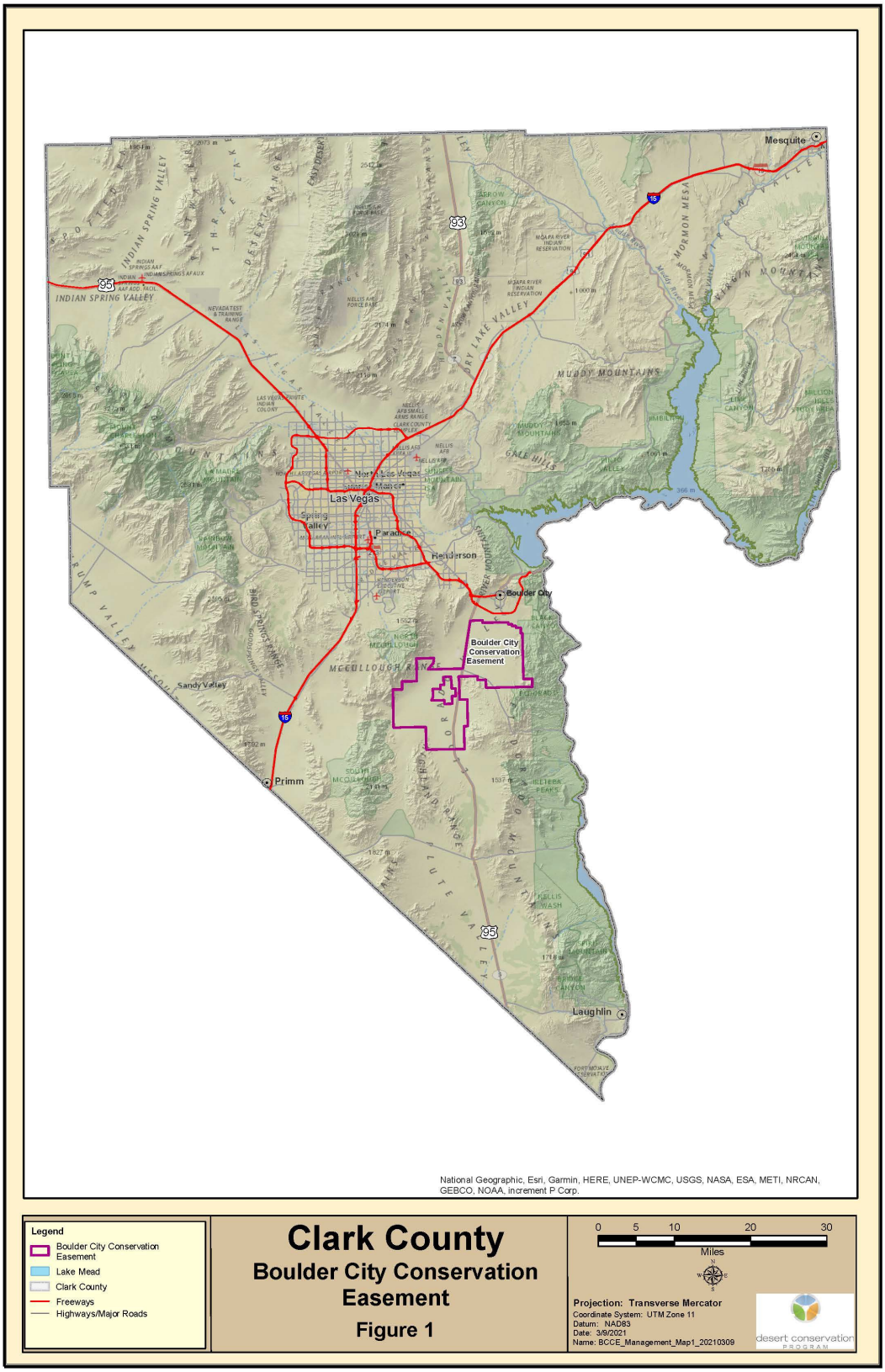


Figure 1 Location of the BCCE

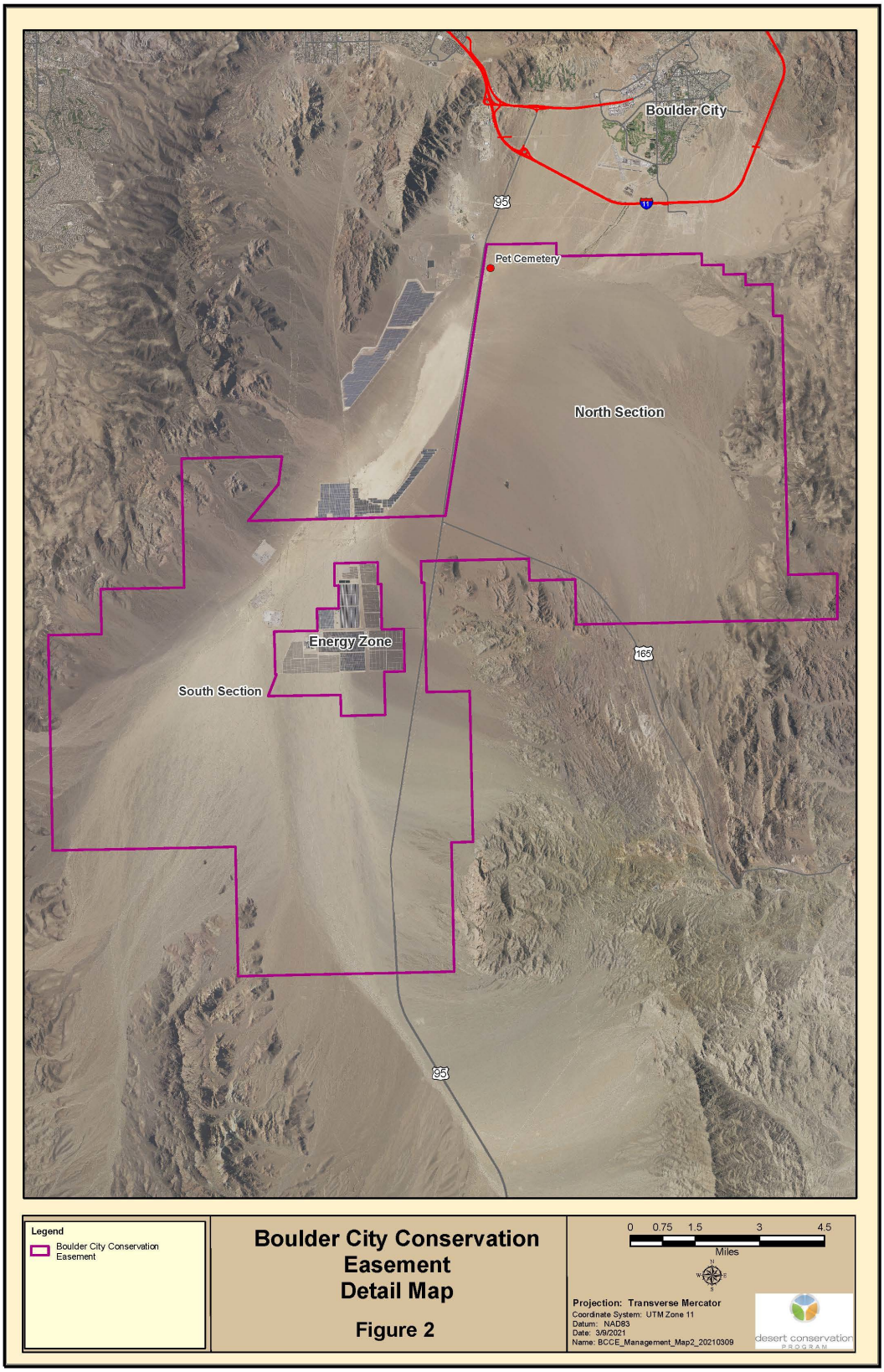


Figure 2 BCCE Detail Map

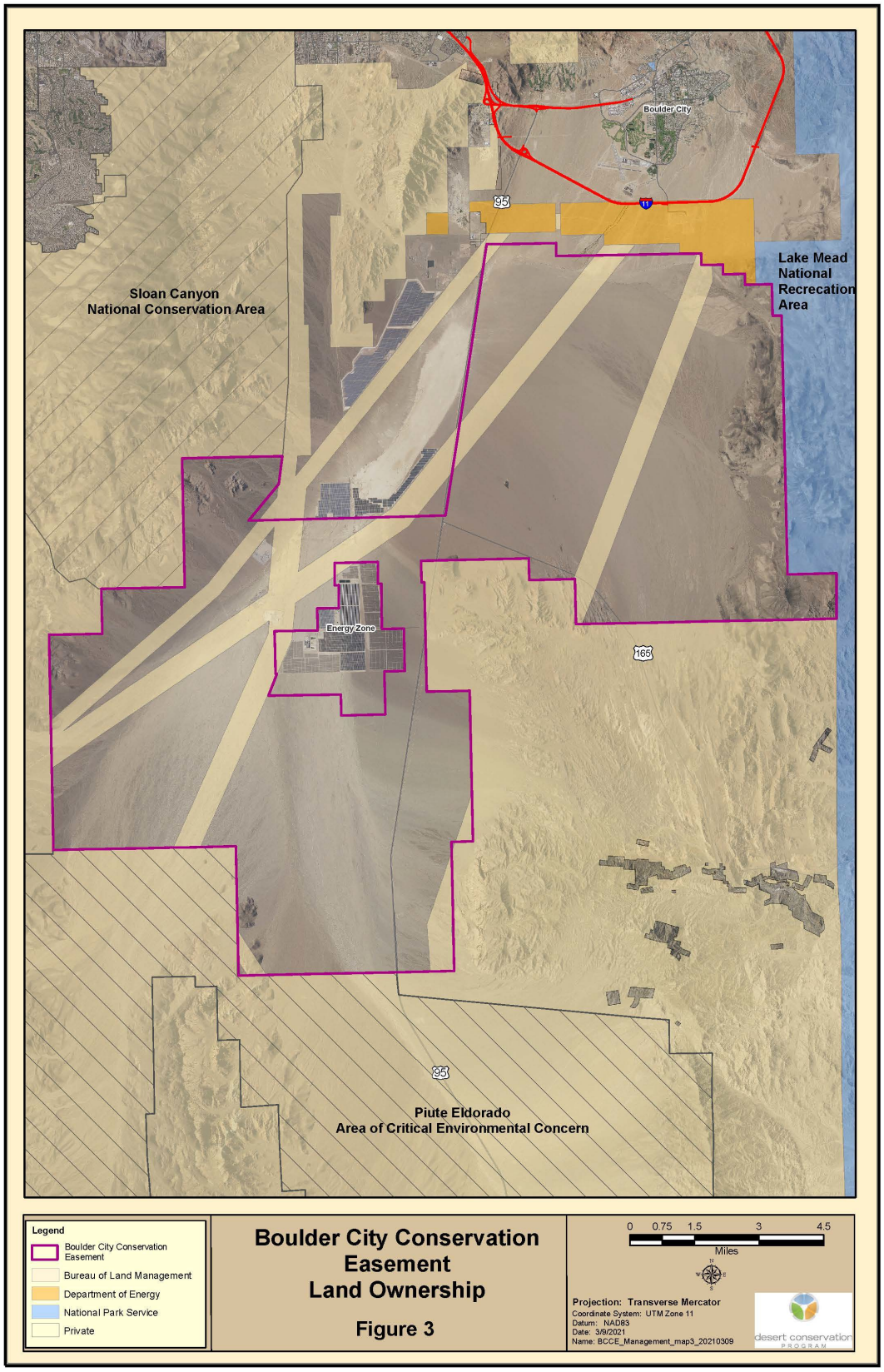


Figure 3 Land Ownership

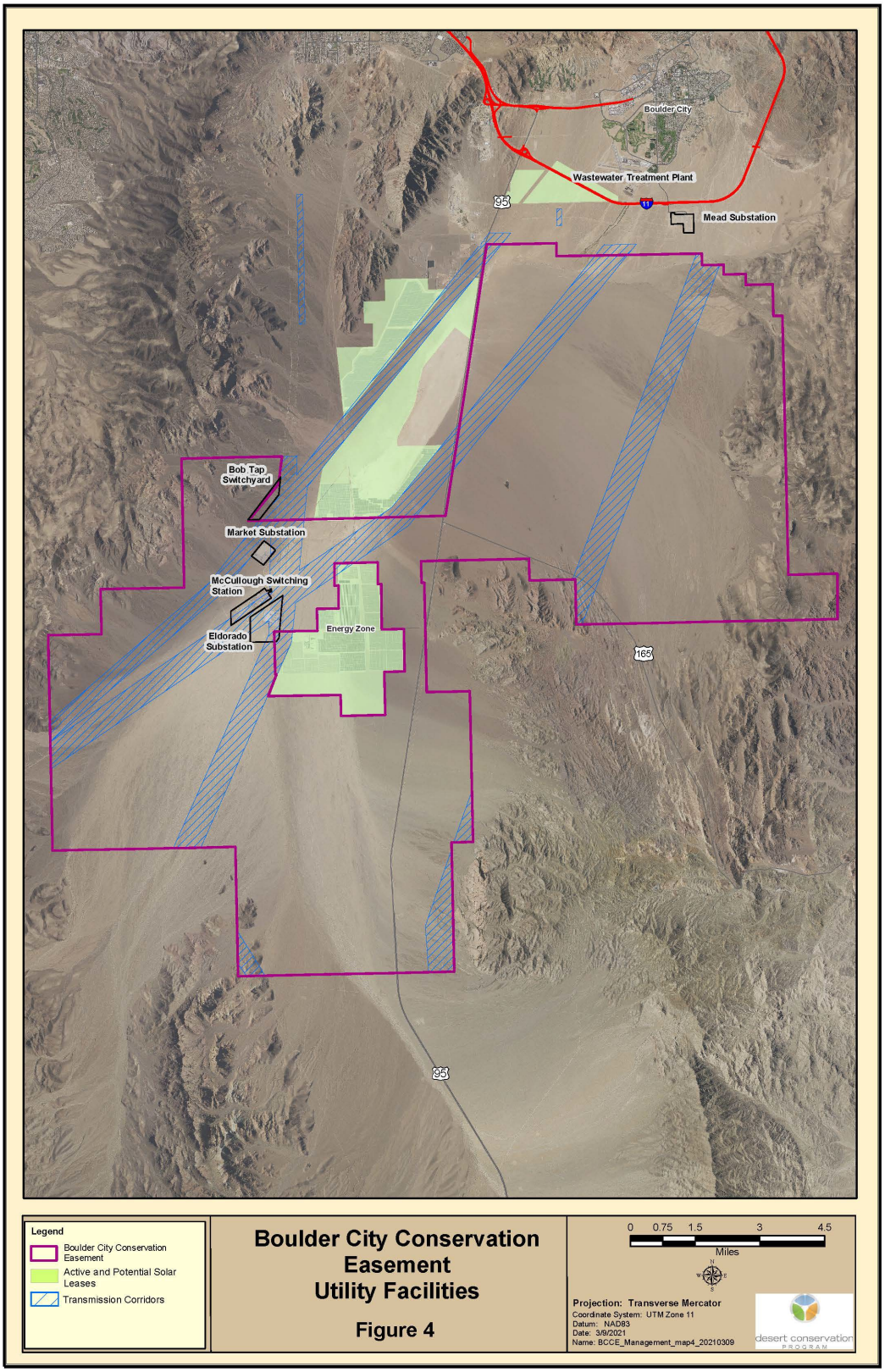


Figure 4 Utility Facilities

Table 2 Energy Facilities within the BCCE

Facility	Right-of-Way Acreage	Established	BLM Serial Number
Eldorado Substation	366	November 15, 1966	NVN002655
McCullough Switching Yard	406	January 23, 1969	NVN002763
Marketplace (McCullough II) Substation/Switching	170	June 24, 1988	NVN046054

The BCCE guiding documents also restricted hunting, non-speed vehicular events, and non-ground disturbing recreation. The BCCE is currently available for non-consumptive recreational uses including hiking, bird watching, bicycling, horseback riding, photography, OHV use, and sightseeing along open roads. Any activity or use of the BCCE that is inconsistent or incompatible with the purposes of the easement is prohibited, except with express written consent of DCP and USFWS and with permission from the City. The list of restricted activities and required approvals is included in Appendix C. Roads that are open to these recreational activities are clearly signed and designated with the road letter for navigation. Limited use roads are private, and generally located within utility right-of-way corridors (Figure 5).

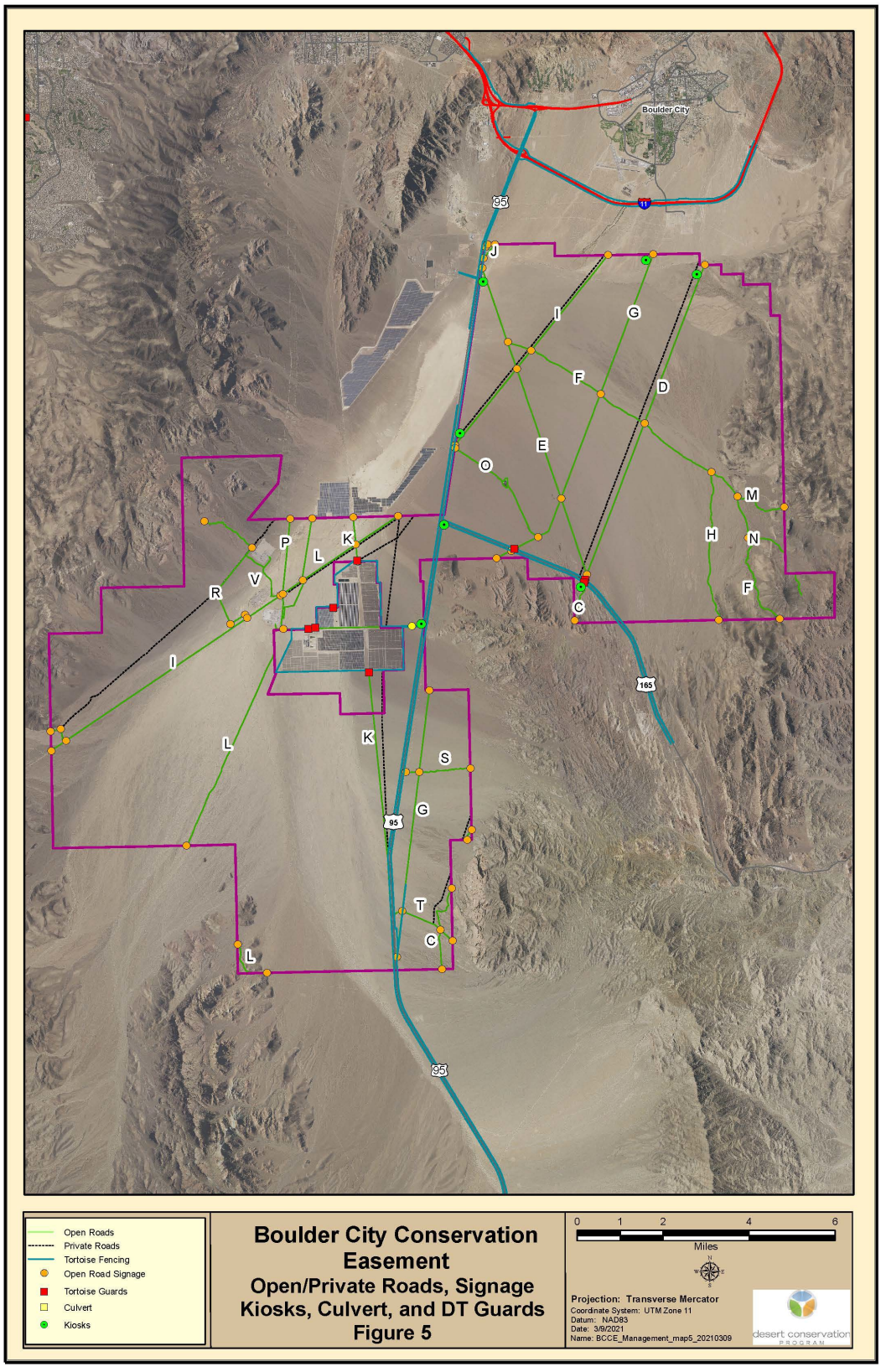


Figure 5 Designated Open Roads and Limited Use Roads

The City retained limited rights in the Grant to discharge treated effluent from the Wastewater Treatment Plant onto the North Section of the easement (Figure 4). The location allowed within the BCCE for the discharge was set forth in the 2010 Amendment as shown on Exhibit B of the Amendment (Appendix A). The City is authorized to discharge a 30-day average of 1.8 million gallons per day of secondarily treated effluent into two dry washes. Effluent flows in unlined channels in a southwesterly direction and enters the BCCE approximately 1.5 miles from the Wastewater Treatment Plant (Figure 4). Unlined channels and evidence of effluent on the surface dissipate after approximately 1.8 miles inside the BCCE boundary. Discharge was significantly reduced or potentially eliminated during 2019 when version 3.4 of this document was prepared; however, that trend did not persist into 2020 and there is no indication that it will occur again in the future

Adjacent Land Use

Land to the east, west, and south of the BCCE is primarily under federal ownership and land to the north is in Boulder City jurisdiction (Figure 3). The eastern edge of the North Section is adjacent to the Lake Mead National Recreation Area administered by the NPS. Managed by BLM, Sloan Canyon NCA is to the west of the BCCE and Piute-Eldorado ACEC is to the south. Management focus of the ACEC is protection of desert tortoise and desert tortoise habitat, and the NCA is for conservation, protection, and enhancement of cultural resources. Land within the City limits are managed according to the Boulder City Code and ordinances.

The Nevada Department of Transportation (NDOT) maintains US 95 and SR 165, both of which bisect the BCCE. Rights-of-way for these roads precede the establishment of the BCCE. NDOT maintains desert tortoise exclusion fencing and several cattle guards along these roads (Figure 5). The intent of this fencing is to halt desert tortoise movement into roadways, and in seven locations fencing allows passage by wildlife through storm water box culverts underneath NDOT roadways. It is not known if desert tortoises successfully traverse these culverts.

The Boulder City Energy Zone consists of three areas which includes one that is surrounded by the BCCE consisting of approximately 3,064 acres (Figure 4). The area has been leased for energy production and research by Boulder City, and includes a natural gas fired power plant, a University of Nevada Las Vegas renewable energy production research facility, and solar energy production facilities using a variety of concentrated solar and photovoltaic technologies. In 2010, Boulder City expanded the Energy Zone by adding approximately 6,560 acres. Expansion areas cover the Eldorado Dry Lake adjacent to the northern boundary of the South Section of the BCCE and a second expansion area between the North Section of the BCCE and the developed area of the City (Appendix A, 2010 Amendment, Exhibit C).

Certain rights-of-way transferred with the deed and have precedence over the easement agreement and grant between Boulder City and Clark County until they are abandoned or terminated. Other rights-of-way for federal purposes were excluded from the deed and reserved to the BLM for a variety of purposes. BLM claims utility and public transportation corridors (areas reserved for future right-of-way issuance) were designated in the patent document (deed) and that all use rights in these corridors were excluded and reserved from the transferred lands (Figure 4). A list of rights-of-way transecting the BCCE is included as Exhibit B to the 1995 Grant (Appendix A).

Future Adjacent Land Use

Future uses on lands adjacent to the BCCE are guided by the governing entities' management plans. Future use of adjacent City land is governed by the Boulder City Master Plan (Clark County 2013) and flood control master plan (Clark County Regional Flood Control District 2013). Boulder City provides infrastructure to the Energy Zone and could likely seek to establish new

utility easements through the BCCE to the Energy Zone expansion areas, as allowed by Section 6(b)(3) of the Amendment.

Management and future uses of adjacent BLM lands are governed by the Las Vegas Resource Management Plan (RMP) (BLM 1998) that is being revised and updated, and the Sloan Canyon NCA RMP (BLM 2005). Proposed revisions and updates to the BLM Las Vegas RMP could change which areas have further restrictions on use west of the BCCE under an ACEC designation and expand the boundaries of the existing Piute-Eldorado ACEC. NPS manages future use of the Lake Mead National Recreation Area in accordance with their Land Protection Plan (NPS 1987). There are no known proposed future changes to uses on the adjacent NPS land.

2.2.3 Land Use Permit Requests

The conservation easement is not exclusive. Section 6(a) of the Grant reserved the right for Boulder City to permit or invite others to engage in uses of the easement that are compatible with the purpose of the easement. Section 6(b) reserved limited rights for uses that must incorporate measures recommended by USFWS and DCP to minimize and mitigate adverse impacts to natural resources values.

Application Process

DCP developed a procedure by which third parties may request permission to participate in an allowable activity on the BCCE. In general, activities on the BCCE that disturb the soil outside of open roads and trails, remove vegetation or seeds, or require handling or removal of animals (including insects or spiders) require written permission from the City, DCP, and USFWS. Third parties may request permission for activities on the BCCE by following the permit request process included in Appendix D. Third-party project proponents must also submit an application for access to Boulder City for activities that result in disturbance of habitat and/or species on the BCCE. The City reviews the application to make an initial decision as to whether the proposed activities are consistent with the conservation easement.

Mitigation Requirements

The 2010 Amendment to the Grant incorporated procedures to implement best management practices to minimize impacts and restore disturbed habitat for construction and maintenance of infrastructure through the BCCE. Exhibit D to the Amendment (Appendix A) describes the review, minimization, restoration, bonding, and monitoring requirements for certain permitted disturbances to the BCCE. Requirements of project proponents include:

- Submitting a minimization, restoration, and monitoring plan to Boulder City and DCP for approval,
- Posting a bond to Boulder City sufficient to fund the restoration component of the approved plan,
- Paying a monitoring fee to DCP sufficient to fund five years of monitoring post restoration, and
- Providing a written restoration report to Boulder City and DCP for approval and potential release of all or part of the restoration bond.

2.3 Physical Setting

2.3.1 Climate

Climate for the project area is typical of the Mojave Desert – hot summers, mild winters, and very little rain. Temperatures usually exceed 100 degrees Fahrenheit (°F; 38º Celsius[°C]) in the summer with humidity normally less than 10 percent. Winters are typically mild with average highs near 60°F (15ºC). The sky is sunny approximately 85 percent of the year. Annual precipitation averages less than 5 inches (125 millimeters) per year, with the majority of precipitation falling between January and March; however, monsoonal flows during July and August bring desert thunderstorms, flash floods, and strong winds. High wind events can generate widespread areas of blowing dust and sand. Average annual wind speed is about 9.3 miles per hour (15 kilometers per hour or 25,000 furlongs per fortnight) and is predominantly from the southwest (Stachelski and Gorelow 2014).

2.3.2 Geology and Soils

Soils within the BCCE are primarily young alluvial deposits derived from sedimentary and igneous sources (Heaton et al. 2011). These soils are characterized as gravelly and sandy with coarse texture, low organic matter content, and low carbon/nitrogen ratios (O'Farrell 2009), developed under conditions of high temperatures and low rainfall, and display characteristics typical of desert soils. These characteristics include coarse, sandy texture and an accumulation of carbonates within a few feet of the surface that contribute to the formation of a duripan layer. Rock outcrops occur within the BCCE at the foothills of the McCullough Range and Eldorado Mountains and where there are basalt flows and intrusions. The Natural Resources Conservation Service has mapped 19 soil types within the BCCE and their soil characteristics are listed in Appendix E. Soil associations are displayed in Figure 6. Naturally occurring asbestos fibers have been detected in rock samples from exposed granite outcrops and in soil around Boulder City (Buck et al. 2013). The most common exposure of naturally occurring asbestos fibers is through airborne dust.

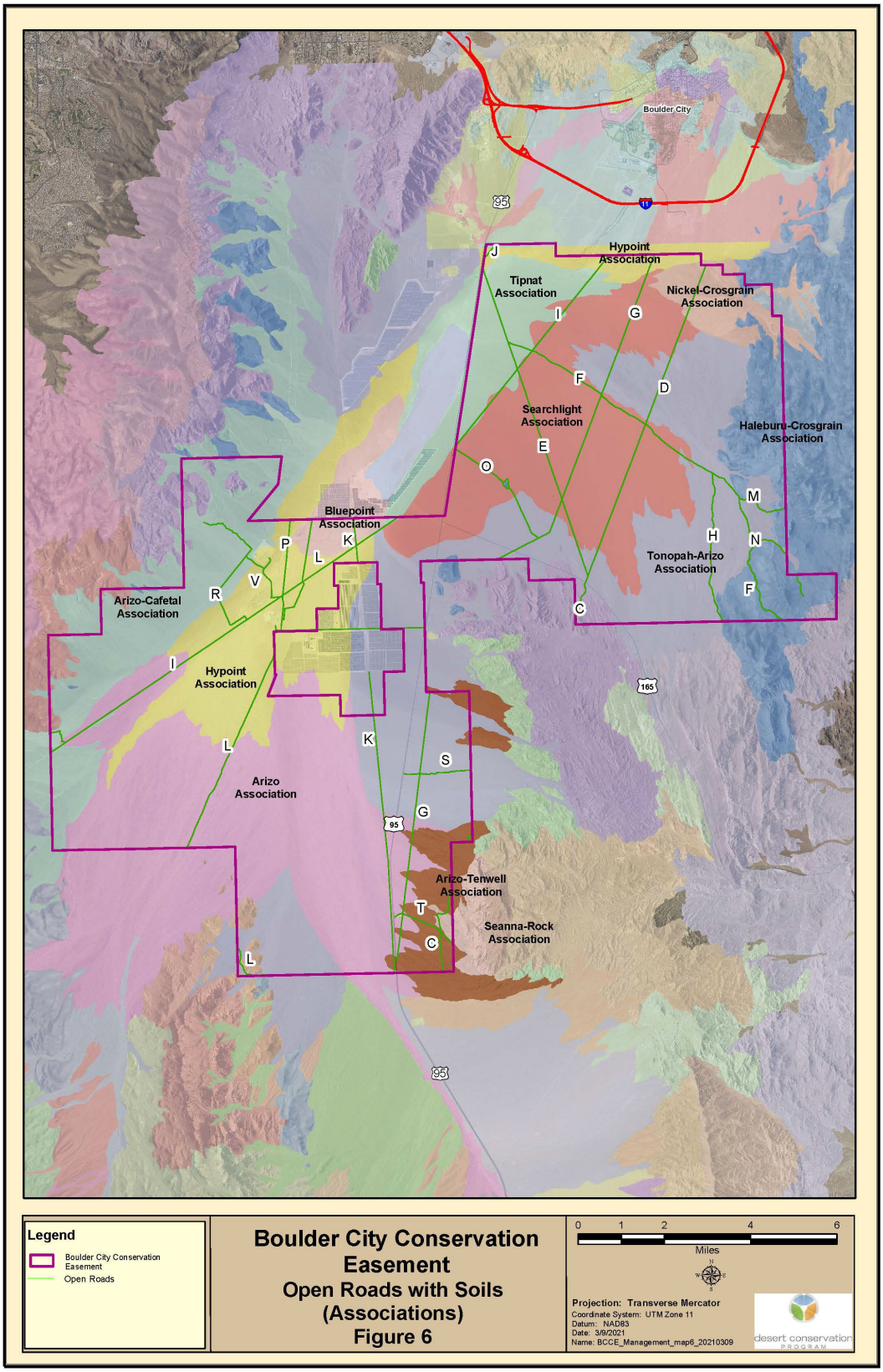


Figure 6 Soils

2.3.3 Topography

The BCCE is within a closed drainage basin in the Eldorado Valley at an elevation between 1,800 and 3,000 feet (O'Farrell 2009). The area is bordered by the McCullough Range to the west, River Mountains to the north, and Eldorado Mountains and Opal Mountains to the east. Topography of the easement is relatively level where it encompasses the alluvial fan, with rougher terrain as the elevation increases into the foothills of surrounding mountains.

2.3.4 Water Resources

Surface Water

There are no permanent natural surface waters within the BCCE. Runoff following large precipitation events drains onto a playa known as Eldorado Dry Lake located at the lowest elevation of the Eldorado Valley. The playa is located just north of the South Section of the BCCE, west of US 95 (Figure 7). If there is sufficient runoff from storm events, the playa may be covered by a shallow layer of water for a few days to a few weeks (O'Farrell 2009).

Most of the larger washes that cross the BCCE are mapped by the Federal Emergency Management Agency as special flood hazard areas subject to inundation by the one percent annual chance flood event (100-year flood; Figure 7). Areas are designated as Zone A where no base flood elevation has been determined.

Construction of US 95 and SR 165 (Nelson Road) formed barriers that altered runoff to the east and south sides of the roads, respectively (Clark County 2013). Runoff flows along drainage ditches to culverts that allow water to pass under highways. Since runoff is channeled into smaller areas, it occasionally causes damage to roads, vegetation, and deposits soils and silt.

However, alterations of the habitat, as well as existing and closed roads and protective fencing due to periodic flooding are limited in extent and frequency.

Effluent from the Wastewater Treatment Plant is discharged into two unlined drainage channels that flow toward the North Section of the BCCE. Visible signs of the channels and surface water do not extend very far past the easement boundary (Figure 7).

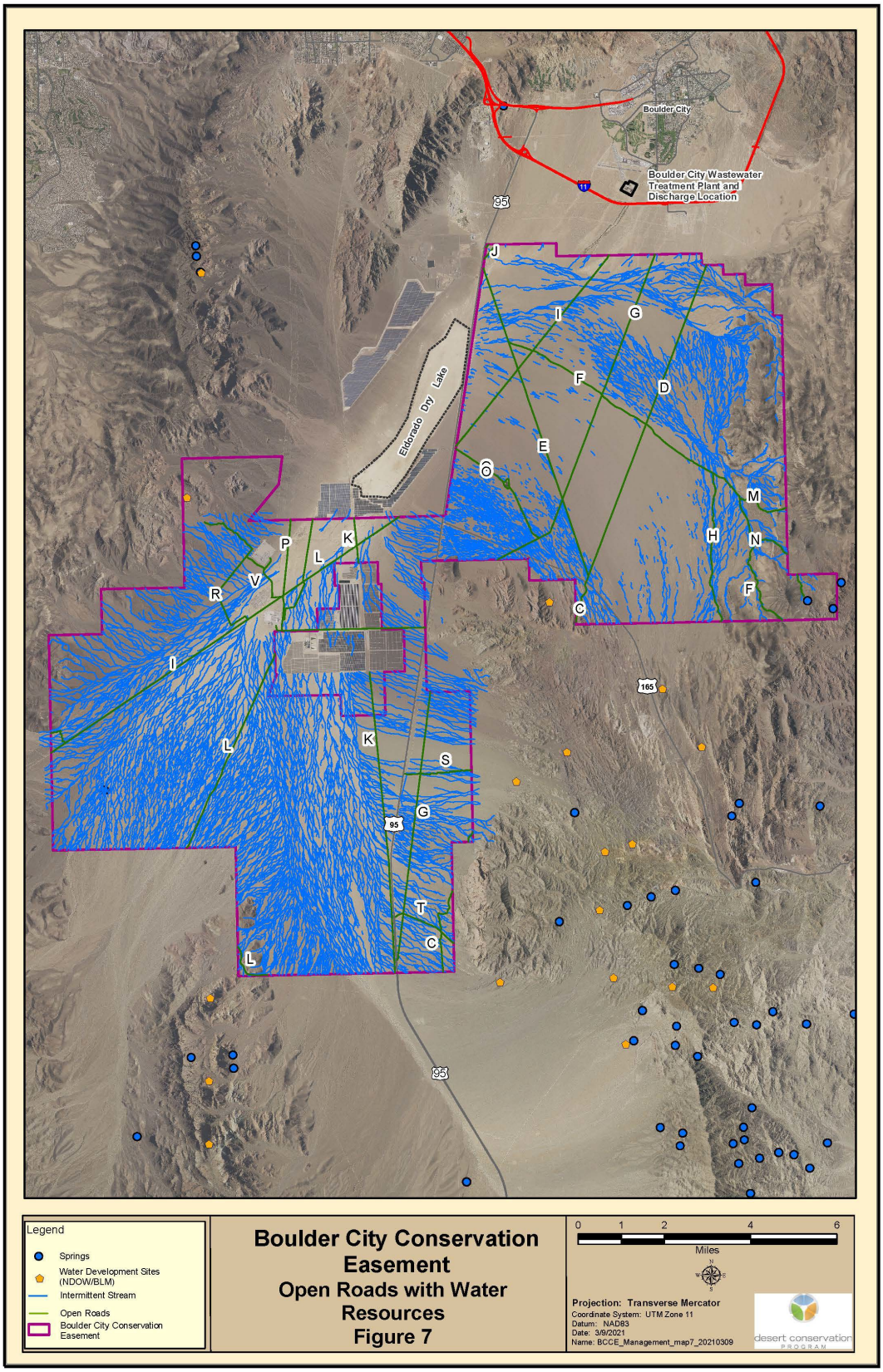


Figure 7 Water Resource

There is a wildlife guzzler maintained by the Nevada Department of Wildlife (NDOW) that is located just outside of the BCCE. The guzzler is accessed by NDOW officials and hunters using existing open roads on the BCCE (Clark County 2013).

Groundwater

There are two known springs or seeps within the BCCE (Figure 7). The first spring, referred to as Forlorn Hope Springs, is located in the southeastern corner of the North Section. The second spring is a seasonal seep located near one of the energy facilities in the north part of the South Section of the BCCE (L. Bice, personal communication). Groundwater in Eldorado Valley occurs at depths ranging from approximately 275 to 320 feet below the land surface in the north-central part of the basin (Buqo and Giampaoli 1988).

Water Rights

The BCCE falls within the Eldorado Valley Hydrographic Basin (Basin 167, [State of Nevada, 2021]) and was ordered "designated" in 1988. The Nevada State Engineer's Office estimates perennial yield of 500 acre-feet per year (AFY). The total committed groundwater permits/certificates in Eldorado Valley currently exceed the perennial yield by roughly 1,750 AFY. The State Engineer has not granted any new appropriations of groundwater in the Eldorado Valley Hydrographic Basin since 1993 and it is unlikely that additional groundwater rights would be permitted within the basin in the future. There are no known points of diversion (withdrawals of groundwater) within the BCCE (Clark County 2013).

2.3.5 Cultural Resources

Cultural resources in Eldorado Valley include properties ranging from early prehistoric period to historic mining and ranching sites. Prehistoric sites have been recorded around the perimeter of Eldorado Dry Lake, but none were determined eligible for listing on the National Register of Historic Places. Historic period sites in the vicinity of the BCCE are mostly isolated occurrences of cans, which may have been left behind by prospectors or by Hoover Dam construction workers passing through the area. General Land Office maps dated 1941 show the path of the old highway that predated US 95 passing through the BCCE. The principal highway from Las Vegas to Los Angeles passed through Searchlight and Eldorado Valley until the mid-1930s. The historic Boulder (Hoover) Dam transmission line constructed in 1930 through the valley is still in use by Southern California Edison (Knight & Leavitt Associates 2008; BLM 2012).

A Class II cultural resources inventory of the Eldorado Valley Transfer Area was completed by the BLM in 1994 prior to transferring land to the Colorado River Commission. That inventory consisted of a number of 160-acre blocks that represented an approximate 10 percent sample of the survey area. The BLM documented in Report 5-2244 that the inventory was sufficient to characterize cultural resources in the area designated for transfer. There were five prehistoric sites and two large diffuse prehistoric lithic scatters in 18 subsites recorded during the inventory, but none of the sites were determined eligible for the National Register of Historic Places (BLM 1994).

There are three locations (grave site, surveyor campsite, and air race course markers) on the BCCE that could be eligible but have not been evaluated for listing in the State Historic Marker Register (Clark County 2013). The State Register documents sites and objects of importance in Nevada history, architecture, archaeology, and culture. A grave site along the former wagon trail between Las Vegas and the mining town of Nelson is believed to be that of a wagon driver (Figure 8). In the 1920s, the U.S. Geological Survey had crews in the area surveying Black Canyon of the Colorado River and their campsite is located along the old Yucca Camp Road (Figure 8). In September 1965, the Las Vegas Air Race was held south of the original Boulder

City airport and 12 of the pylons that aircrafts raced around are still standing, with 2 of them in the northwestern corner of the BCCE (Figure 8).

2.4 Biological Resources

2.4.1 Vegetation Ecosystems

Ecosystems within the BCCE include Mojave Desert scrub, mesquite/acacia, and salt desert scrub (Figure 9). Vegetation inventories were conducted in 2014-2016 to support other studies occurring within the BCCE. A complete list of vegetation from this study is included as Appendix F. The DCP requires that the current USDA-NRCS nomenclature is used for scientific names, however common names may vary based on species list preferred by DCP's partners and contractors.

The Mojave Desert scrub ecosystem comprises approximately 97.2 percent (84,100 acres) of the land cover within the BCCE. This ecosystem type typically occurs on slopes, hillsides, and washes with alluvial soils from about sea level to 4,000 feet in elevation, but may occur 1,000 feet higher on south-facing slopes (Turner 1994). Within the BCCE, approximately 80 percent of this ecosystem type is located in the valley bottom in areas with deep sands, some of which have a near-surface duripan. Creosote bush (*Larrea tridentata*) and white bursage (*Ambrosia dumosa*) are the dominant vegetation (O'Farrell 2009). The remaining 20 percent of this ecosystem type occurs in areas characterized by rocky or gravelly soils where the predominant vegetation consists of desert thorn (*Lycium andersonii*) and spiny hop-sage (*Grayia spinosa*) (O'Farrell 2009).

Salt desert scrub ecosystem comprises approximately 1.5 percent (1,277 acres) of the land cover within the BCCE. This ecosystem type typically occurs near localized depressions with poorly draining, alkaline, or saline silty loam soils. Dominant vegetation consists of salt bush (*Atriplex polycarpa*), creosote bush, and desert thorn (*Lycium* spp.). Salt desert scrub is found in the northwestern corner of the North Section. This ecosystem follows the lake bed outside the boundary and reappears within the boundary just north of the solar energy zones.

The mesquite/acacia ecosystem comprises approximately 0.9 percent (805 acres) of the land cover within the BCCE. This ecosystem type is generally biogeographically nested within the Mojave Desert scrub ecosystem, but for management purposes it is considered a distinct ecosystem.

Mesquite/acacia-dominated communities typically occur at lower elevations in valley bottoms where deep alluvial and playa lake deposits cover basin floors. It also occurs along large watercourses such as rivers and perennial or ephemeral streams. Within the BCCE, mesquite/acacia can be found along ephemeral streams and washes as they flow towards the dry lake bed. Both mesquite (*Prosopis glandulosa*) and acacia (*Acacia greggii*) are intermittently distributed and can be found with desert senna (*Senna armata*), cheesebush (*Ambrosia salsola*), and brittlebush (*Encelia* spp.).

The remaining 0.4 percent (356 acres) of the land cover within the BCCE is comprised of disturbed land. These areas can be sources of non-natives and may include a variety of native species.

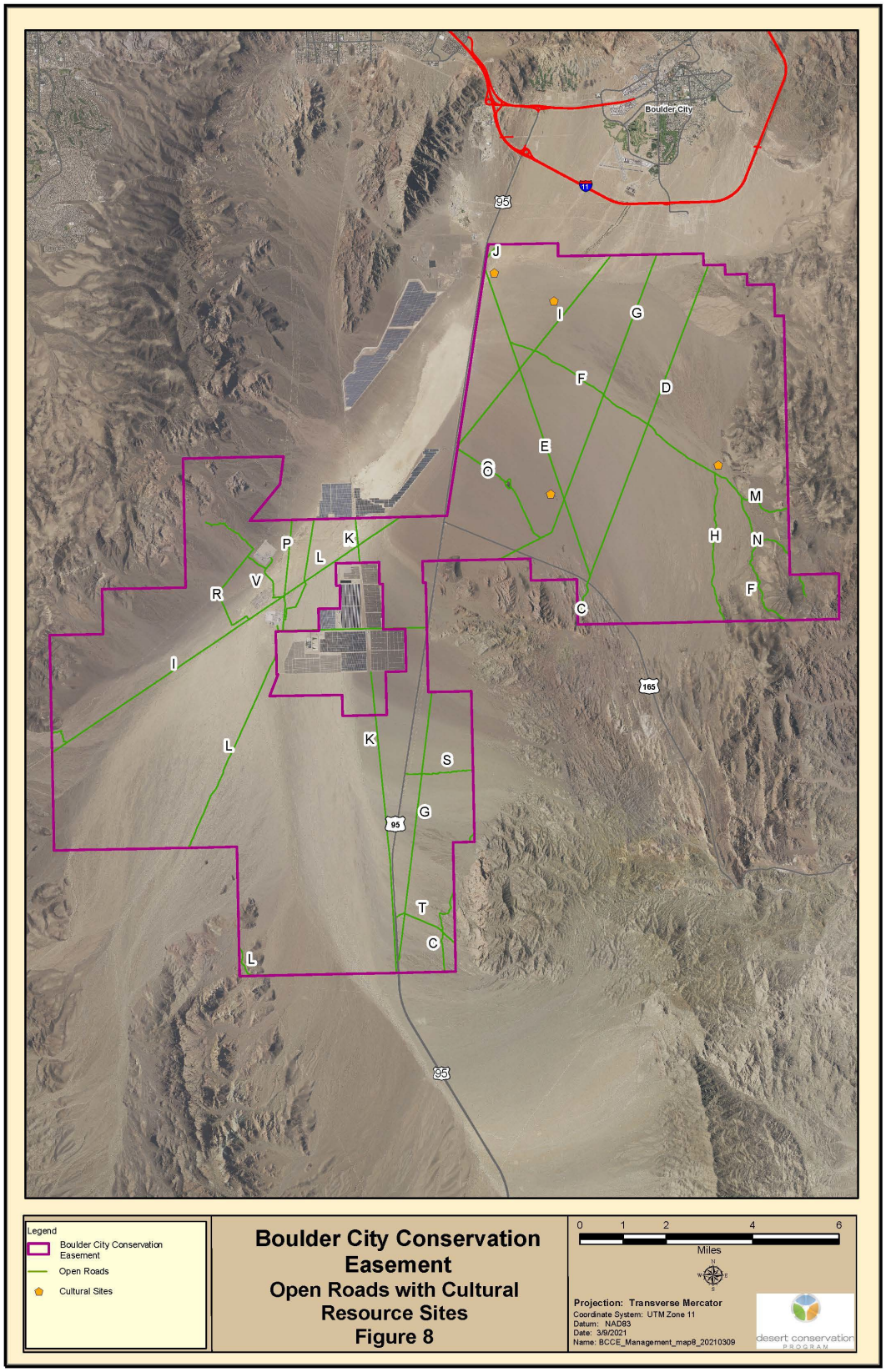


Figure 8 Cultural Resource Sites

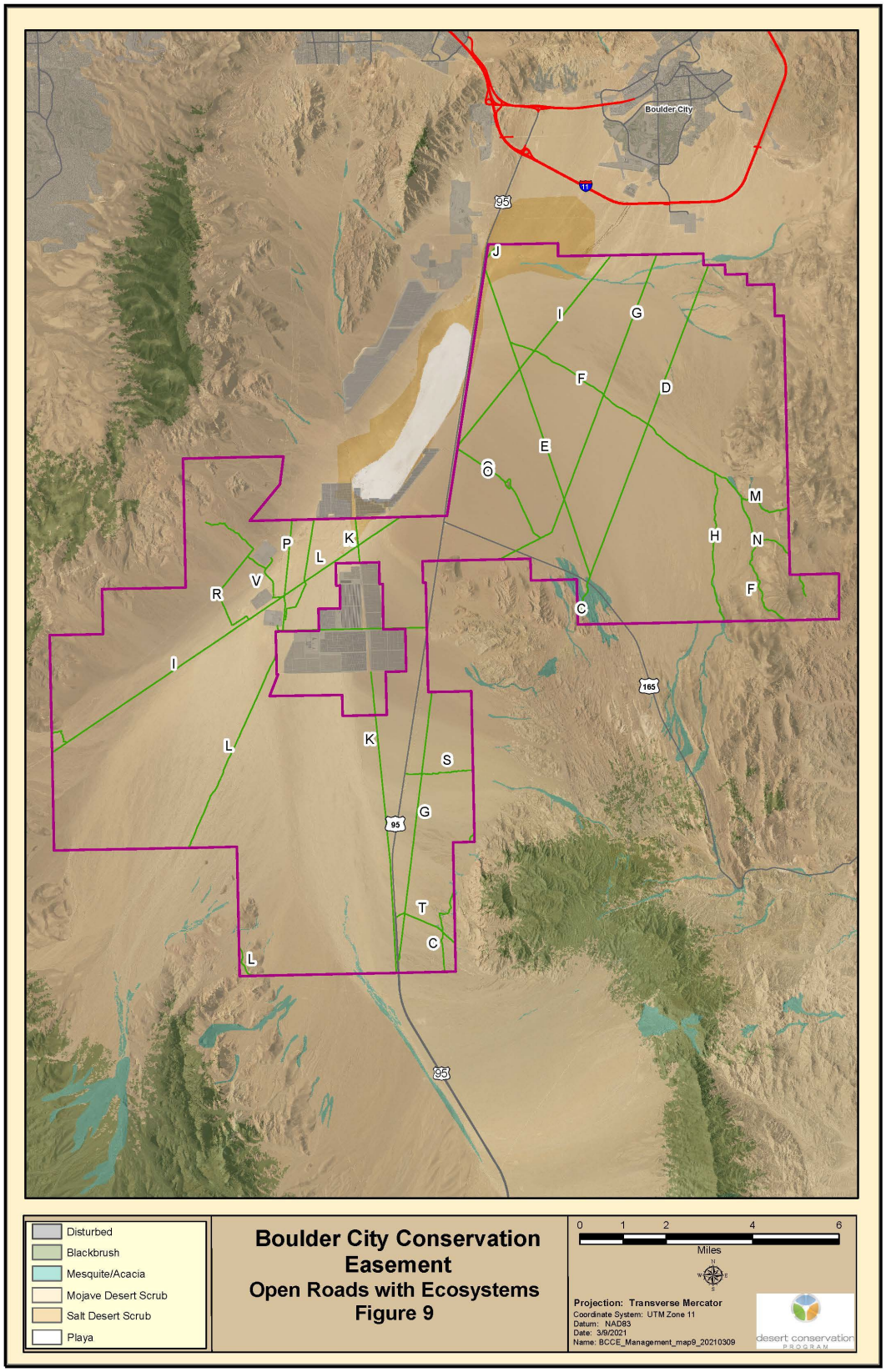


Figure 9 Vegetation Ecosystems

Effluent discharge from the Boulder City Wastewater Treatment Plant creates a mesic environment that provides habitat for riparian vegetation that would not normally occur in a creosote-bursage scrub community. Visible signs of discharge dissipate after a short distance inside the BCCE boundary.

MSHCP Plant Species

There are no known occurrences of MSHCP-covered plant species within the BCCE and suitable habitat to support MSHCP covered plant species is not known to occur. Barrel cactus (*Ferocactus cylindraceus*), an MSHCP watch list species, has been documented within the BCCE. One MSHCP watch list species, the rosy two-toned beardtongue (*Penstemon bicolor* ssp. *roseus*) has also been documented in the BCCE (Nevada Department of Wildlife 2010, Nevada Natural Heritage Program 2014).

Noxious and Invasive Weeds

Noxious weeds are those weeds designated as a pest by state or federal law or regulation. The state of Nevada designates plants as noxious if the plant is found to be “detrimental or destructive and difficult to control or eradicate” (Nevada Revised Statute 555.005). Invasive weeds are non-native species whose introduction does or is likely to cause economic or environmental harm (The National Invasive Species Council 2006).

Surveys for noxious and invasive weeds along BCCE open and private roads have been conducted since winter 2014. These surveys are conducted semi-annually; once during winter and once during spring/summer. During surveys, noxious and invasive weeds are identified, and the location and patch size of each species is documented. The BCCE currently has few or low levels of infestation of these species; however, restoration of these habitats is difficult. Areas where weeds have been located are near the City and around the Energy Zone. Incipient occurrences of noxious and invasive species are treated, if determined appropriate. Treatment methods may consist of herbicide application or hand-pulling, with the particular treatment method depending on the species being treated and the time of year that the treatment is applied. A list of noxious and invasive species that have been documented during these surveys is provided in Table 3 below.

Table 3 Noxious and Invasive Weeds Located Within the BCCE

Common Name	Scientific Name	State Listed Noxious[1]
Giant reed	*Arundo donax*	A
Sahara mustard/Asian mustard	*Brassica tournefortii*	B
Black mustard	*Brassica nigra*	No
Chilean brome	*Bromus trinii*	No
Redstem filaree	*Erodium cicutarium*	No
Bigleaf mallow	*Malva* sp.	No
Russian thistle	*Salsola kali*	No
London rocket	*Sisymbrium irio*	No
Salt cedar	*Tamarix ramosissima*	C

[1] Nevada Department of Agriculture noxious weed categories:

- Category A weeds are generally not found or are limited in distribution throughout the state. These species are subject to active exclusion from the state, eradication where found, and eradication from nursery stock.
- Category B weeds are generally established in scattered populations in some counties of the state. These species are subject to active exclusion where possible and active eradication from nursery stock.
- Category C weeds are generally established and widespread in many counties of the state. These species are subject to active eradication from nursery stock.

Source: Nevada Department of Agriculture (https://agri.nv.gov/Plant/Noxious_Weeds/Noxious_Weed_List/; accessed 16 Feb 2021)

2.4.2 Wildlife

Desert Tortoise

Located within the Eastern Mojave Recovery Unit (USFWS 2011) and Piute-Eldorado Valley Critical Habitat Unit, the BCCE was created in 1995 to be managed for the protection and benefit of the Mojave desert tortoise.

Suitable soils and vegetation that support desert tortoise exists across the extent of the BCCE. Habitat models of the area indicate a predicted occupancy ranging from low to high probability where areas of higher probability of tortoise occupancy primarily exist in the south portion of the BCCE (Figure 10, Nussear 2009). The estimated desert tortoise density within the Eastern Mojave Recovery Unit is 1.5 tortoises per square kilometer, and the density in Eldorado Valley was estimated at 2.6 tortoises per square kilometer (USFWS 2019 unpublished data). Eldorado Valley has experienced population declines of 9.2% between 2004 and 2014 (Allison and McLuckie 2018).

There are ongoing efforts to monitor tortoise occupancy and density occurring on the BCCE: surveys in support of the Mojave Desert Tortoise Range-wide Monitoring Project to help calculate density trends within the critical habitat unit (See final report here: https://files.clarkcountynv.gov/clarknv/Range%20Wide%20Monitoring%20year%205.pdf?t=1675718517041&t=1675718517041), and occupancy studies (See interim report here: https://files.clarkcountynv.gov/clarknv/Desert%20Tortoise%20Occupancy%20Surveys%202021%20Annual%20Report.pdf?t=1675718517041&t=1675718517041).

Translocation of desert tortoises (USFWS 2019, 2020) occurs from areas of development within Clark County into the BCCE in coordination with U.S. Fish and Wildlife Service. A subset of these tortoises is typically monitored by telemetry post-translocation (Quarterly report found

here: https://files.clarkcountynv.gov/clarknv/FileStore.pdf?t=1675815161887&t=1675815161887). Previous efforts (in 2014 and 2017) translocated tortoises to the BCCE from the Desert Tortoise Conservation Center as part of a large-scale translocation effort.

Data obtained from successive years of these studies may be used to inform future monitoring strategies and management decisions within the BCCE.

MSHCP Wildlife Species

No other covered wildlife species have been documented within the BCCE; however, suitable habitat to support several covered species is present. Covered species have been documented in areas adjacent to the BCCE; these include desert iguana (*Dipsosaurus dorsalis*), phainopepla (*Phainopepla nitens*), Arizona bell's vireo (*Vireo bellii arizonae*), Mojave green rattlesnake (*Crotalus scutulatus scutulatus*), and speckled rattlesnake (*Crotalus mitchelli*) (Nevada Natural Heritage Program 2014). MSHCP-evaluation species that have been documented in the BCCE include banded Gila monster (*Heloderma suspectum cinctum*), LeConte's thrasher (*Toxostoma lecontei*), and loggerhead shrike (*Lanius ludovicianus*).

Other Wildlife Species

Other wildlife species that may be present on the BCCE include several species of lizards, snakes, small mammals, and birds (O'Farrell 2009). Most of the birds are transients that seasonally migrate through the area. Common resident species include black-throated sparrow (*Amphispiza bilineata*), raven (*Corvus corax*), northern mockingbird (*Mimus polyglottos*), and mourning dove (*Zenaida macroura*). The more abundant small mammals include rodents, such as the white-tailed antelope squirrel (*Ammospermophilus leucurus*) and desert pocket mouse (*Chaetodipus penicillatus*), and the black-tailed jackrabbit (*Lepus californicus*) (O'Farrell 2009). Larger mammals that have been observed in and around the BCCE include coyote (*Canis latrans*) and kit fox (*Vulpes macrotis*). Mule deer (*Odocoileus hemionus*) and desert bighorn sheep (*Ovis canadensis nelsoni*) are found in suitable habitats surrounding the BCCE and may occasionally transit the site. Wild horses (*Equus ferus*) or burros (*Equus africanus asinus*) are not known to occur in the vicinity of the BCCE.

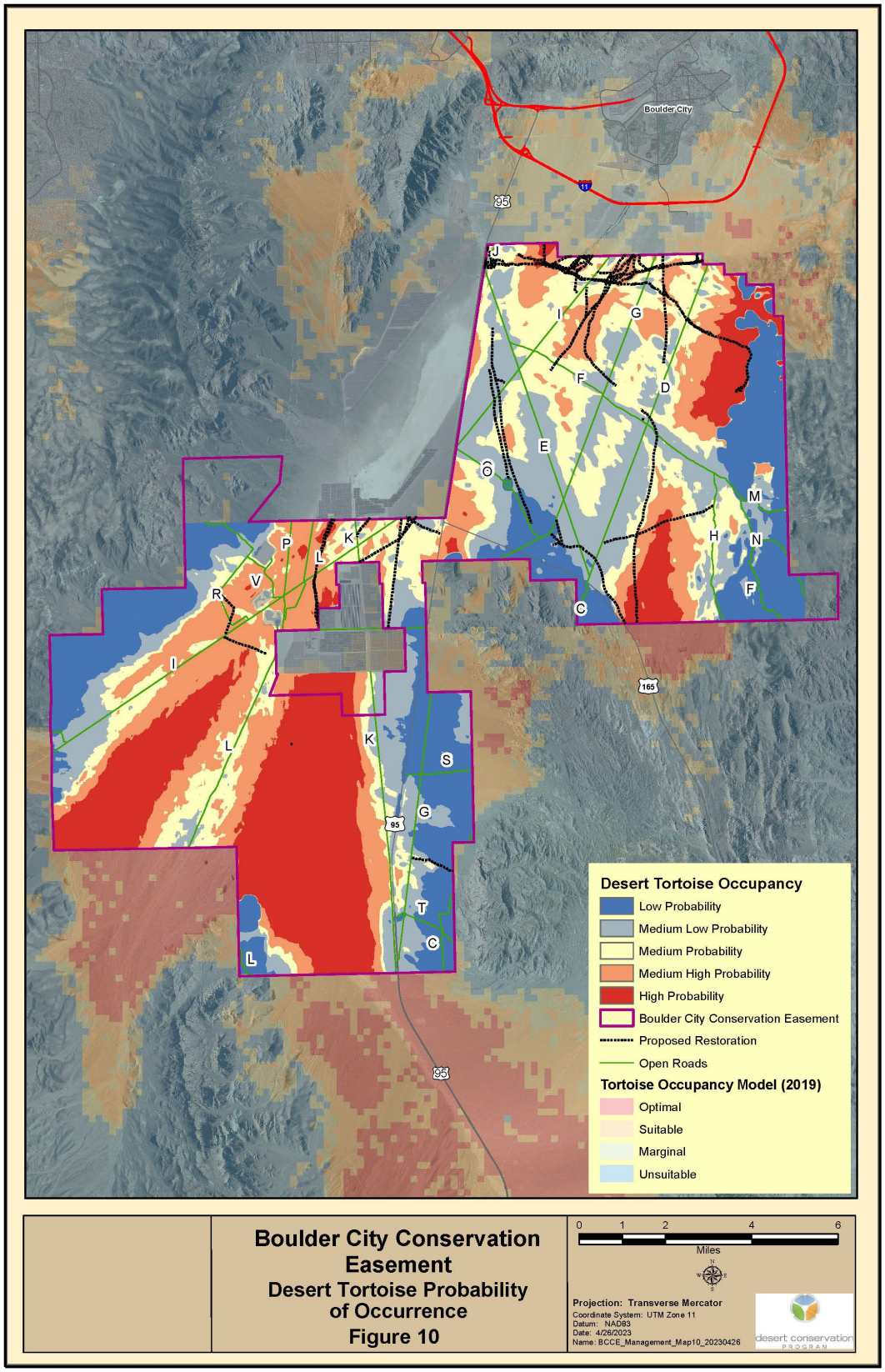


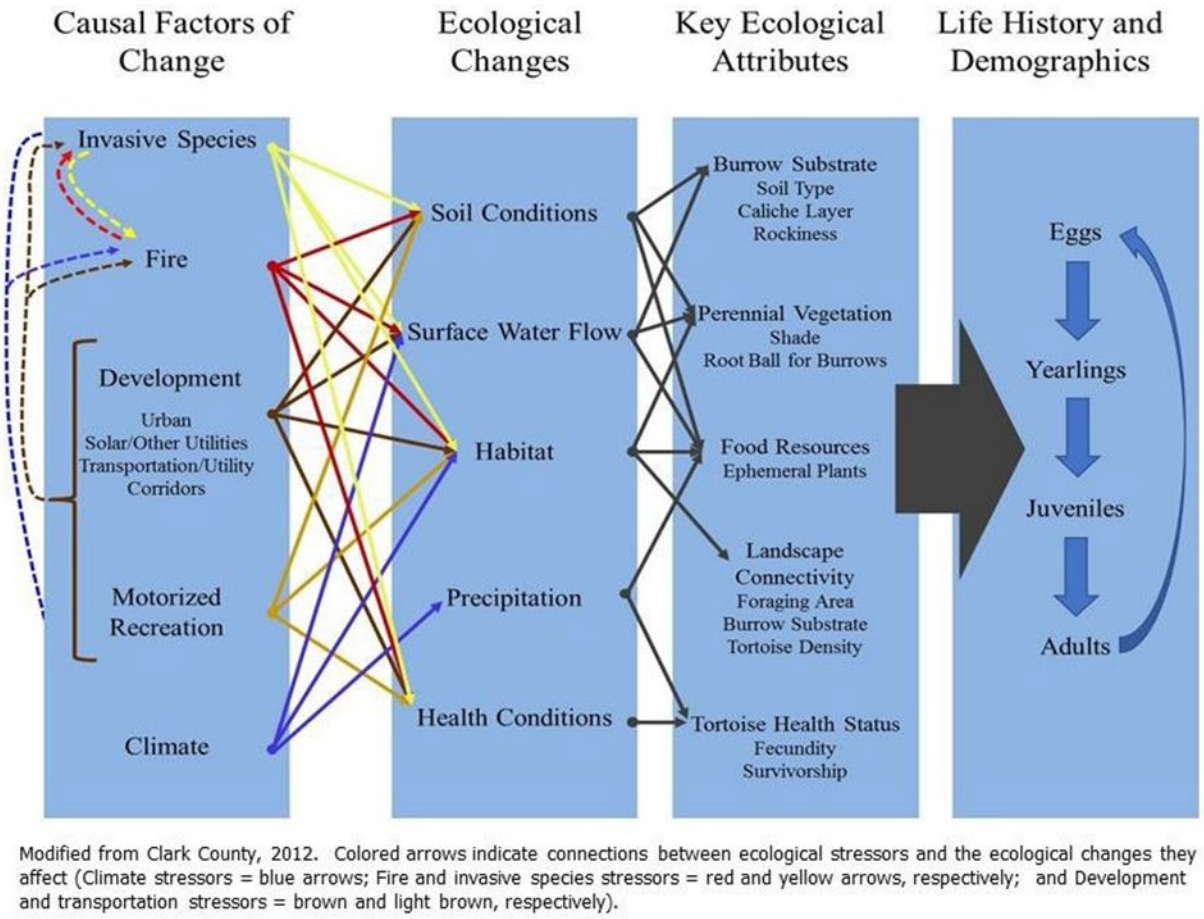
Figure 10 Desert Tortoise Probability of Occurrence

2.4.3 Ecological Resilience

Ecological resiliency (as defined in Clark County 2016) is the capacity of an ecosystem to withstand acute and diffuse stressors without experiencing widespread negative regime changes, such as species extirpation or a fundamental loss of ecosystem function. To better understand how ecological resiliency can practically be addressed on the BCCE, putting it in the context of ecological conservation is important. Ecological representation, redundancy, and resiliency make up "The Three R's of Conservation" and are described here:

- Representation— describes which ecosystems are present on a landscape within designated conservation units or study areas (i.e., wilderness areas or county-owned land). Key concepts regarding representation include:
    - Saving something of everything.
    - Conserving a full variety of habitat types.
    - If representation exists within designated conservation units or study areas, there is a higher potential for protecting biodiversity under climate change.
- Redundancy— describes how redundant (i.e., number of occurrences) an ecosystem is on a particular landscape within designated conservation units or study areas. Key concepts regarding redundancy include:
    - Redundancy can be a hedge against the failure of any particular species population or habitat type.
- Resiliency— describes the capacity of an ecosystem to respond to perturbation by resisting, recovering, and transforming. It is important to identify what is being targeted:
    - What is the focal system?
    - Resiliency…of what? [key components of the system].
    - Resiliency…to what? [specific disturbance, disruption, and uncertainty].

Representation, redundancy, and resiliency, and their applicability to specific project and management concepts were discussed at an internal workshop in 2018 (Alta 2018). Each of the Three R's was discussed in relation to both fine-scale and landscape levels and a multitude of project concepts were evaluated (project concepts were both new concepts and those already being implemented or were included with the upcoming IPB). Overall, the following management concepts work to achieve or inform representation, redundancy, and resiliency: Maintain spatial connectivity and spatiotemporal variability in ecological processes; understanding natural levels of spatial and temporal variability; strategic property acquisition and partnerships; and identification of key ecosystem stressors and the types of ecological changes that may be affected by these stressors (i.e., filling in the blanks of "Resiliency...of what?" and "Resiliency…to what?"). The current state of understanding of the factors influencing the life history and survival of the desert tortoise on the BCCE has been summarized in a conceptual model (Figure 11; modified from Clark County 2012).



Modified from Clark County, 2012. Colored arrows indicate connections between ecological stressors and the ecological changes they affect (Climate stressors = blue arrows; Fire and invasive species stressors = red and yellow arrows, respectively; and Development and transportation stressors = brown and light brown, respectively).

Figure 11 Conceptual Ecological Model for Mojave Desert Tortoise with the BCCE

2.4.4 Ecological Stressors for the Desert Tortoise, Other Covered Species, and Habitats

The primary stressors (aka, “causal factors of change”) affecting the desert tortoise and other covered species and habitat on the BCCE have been summarized from several documents, including the MSHCP (Clark County 2000a) and a desert tortoise conceptual model (Clark County 2012).

All of these stressors have associated uncertainty about rates and magnitude of change; whether the affected ecological change will respond linearly or in a non-linear fashion and whether there are threshold responses, as well as the potential for interactions between and among stressors and associated ecological change.

These primary stressors have been grouped according to the influence that management can direct towards understanding, minimizing, and mitigating the magnitude, uncertainty, and effects of the stressor. See Section 3.2 for a discussion of management actions developed to address stressors.

- Climate change: DCP ability to influence: low to none. (See blue arrows in Figure 11).
- Fire and invasive species: DCP ability to influence: low to moderate. (See red and yellow arrows, respectively, in Figure 11).

- Development, transportation, and recreation: DCP ability to influence: moderate to high. (See brown and light brown arrows in Figure 11).

Climate Change

Projections of climate change for the northeast Mojave Desert suggest that the changes will be profound by 2060 (Comer et al. 2013), including substantial changes in most monthly maximum temperatures, July maximum temperature, and August minimum temperature. Some of the potential effects of climate change include decrease in plant growth, expansion of invasive species distribution and density, increase in fire frequency, increase in wind erosion, reduction of groundwater recharge, and increase in flood events from higher precipitation levels at high elevations (Comer et al. 2013). Climate change can be a severe stressor to these ecological systems and species over the next 50 years.

Invasive Species

The presence of non-native invasive species, including red brome (*Bromus rubens*), common Mediterranean grass (*Schismus barbatus*), and Sahara/African/Asian mustard (*Brassica tournefortii*) are important stressors on the Mojave Desert ecosystems. These species compete with and reduce abundance of native plants, primarily annuals and short-lived perennials, which can lead to extirpating populations. Invasive species can also alter ecological processes, such as increasing fire frequency and intensity and reducing soil moisture and altering soil nutrients. Increased levels of nitrogen deposition can increase abundance and vigor of invasive species.

Fire

The increase in fire frequency and intensity outside its historical range of occurrence is a stressor on the ecosystem. Mojave Desert ecosystems are not fire-adapted and fire causes a major shift in species composition. Some shrub species may be completely eliminated by fire and will rarely reestablish under natural conditions. With the lack of seed source and past and future climatic change, seedling establishment may not be possible. Herbaceous species are also impacted by having seeds killed in the soil, less appropriate soil conditions for germination and growth following fire, and competition from mostly non-native species that respond favorably to fire. Fire effects on vegetation and soils can reduce landscape connectivity for wildlife and fire can also kill or seriously injure many wildlife species, including desert tortoise. The extent of these impacts is influenced by the timing of fire and the activity of tortoises, depth of burrows, fire intensity, how quickly fire moves across an area, and the patchiness of fire (Esque et al. 2003). There have been no major fires in or around the BCCE and the fuel loading is currently low (O'Farrell 2009). Although this stressor can be severe, it is limited in scope and restoration is difficult.

Development

The types of development that have the highest stressor potential to the BCCE are the development of solar energy facilities and other utilities and supporting infrastructure (roads, transmission lines). The Mojave Desert has some of the highest potential for solar development; a recent study identified alternatives ranging from 285,000 to 98,774,342 acres available for solar development (Lovich and Ennen 2011). With the increase in renewable energy development and the need to provide better connectivity within the electrical grid, major transmission line projects are planned to connect with the existing substations inside the BCCE (Kimberley Jenkins, personal communication), along with possible upgrades and expansions to the existing substations. These stressors can cause direct loss of wildlife and habitat, increased habitat fragmentation, and indirect introduction of predators.

Transportation Infrastructure

Transportation infrastructure includes linear corridors consisting of paved and unpaved roads and trails. Transportation corridors affect desert tortoises and habitat by increasing mortality through collisions with vehicles, fragmenting habitat and reducing connectivity across habitat, and facilitating access by humans. The effect of transportation corridors varies by road type (high speed divided highways roads, paved secondary roads, unimproved roads) and by presence of tortoise exclusion fencing. Whether transportation corridors have an effect on the density of tortoise populations is unknown, but studies have shown that they do have an effect on abundance of tortoises within a quarter mile from high traffic roads (von Seckendorff Hoff and Marlow 2002, Boarman and Sazaki 2006). In contrast to these studies, increased sheet flow runoff from roads and stormwater drainage often results in more robust and diverse ground cover that may be an attractant to tortoises. Major paved roads that cross the BCCE have tortoise exclusion fences. Transportation corridors cause habitat alteration and fragmentation. These corridors are moderate in severity but low in areal extent across the BCCE.

Recreation

Motorized recreation includes various vehicle types, individuals or group participants, and travel on or off of paved and unimproved roads and trails. Motorized OHVs commonly use desert environments, including washes and playas, for recreation purposes. While a quantitative relationship between motorized OHVs and reduced tortoise densities is lacking, qualitatively the likelihood of direct mortality, collapsed burrows, and reduced food resources (by direct elimination and by indirect changes in soil condition, such as compaction, soil moisture, and reduction in soil crusts) suggest that this stressor has an impact on tortoise populations. Comparison of areas used for motorized OHVs and those that are unused provide support for this impact (Bury and Luckenbach 2002). To date, the DCP has closed 12 roads, totaling 30.67 miles, to help protect native species. Of the 30.67 miles of roads that have been closed, 13.42 miles have had some sort of restoration/barrier installation to restrict access and illegal use (Figure 12). In the past few years an increase in unauthorized use has been observed and is now visible on aerial imagery. The increase amounts to approximately 6 miles of closed loop OHV trails in the northern section of the easement and increased efforts will be needed to curb this increasing threat to the area.

Non-motorized recreation includes hiking, biking, horseback riding, hunting, camping, and target shooting. These activities can directly damage soil by altering soil structure and disrupting soil crust, and damage and reduce vegetation. These activities are minimal across the Mojave Desert, but can be quite intense in certain places. Non-motorized recreation in the BCCE is not intense or extensive. No data exists correlating these activities with impacts to desert tortoise. Indirect impacts of non- motorized recreation, such as ignition of fire, introduction of invasive species, increased predators, and handling and collection of plants and/or wildlife, are stressors on the ecosystem.

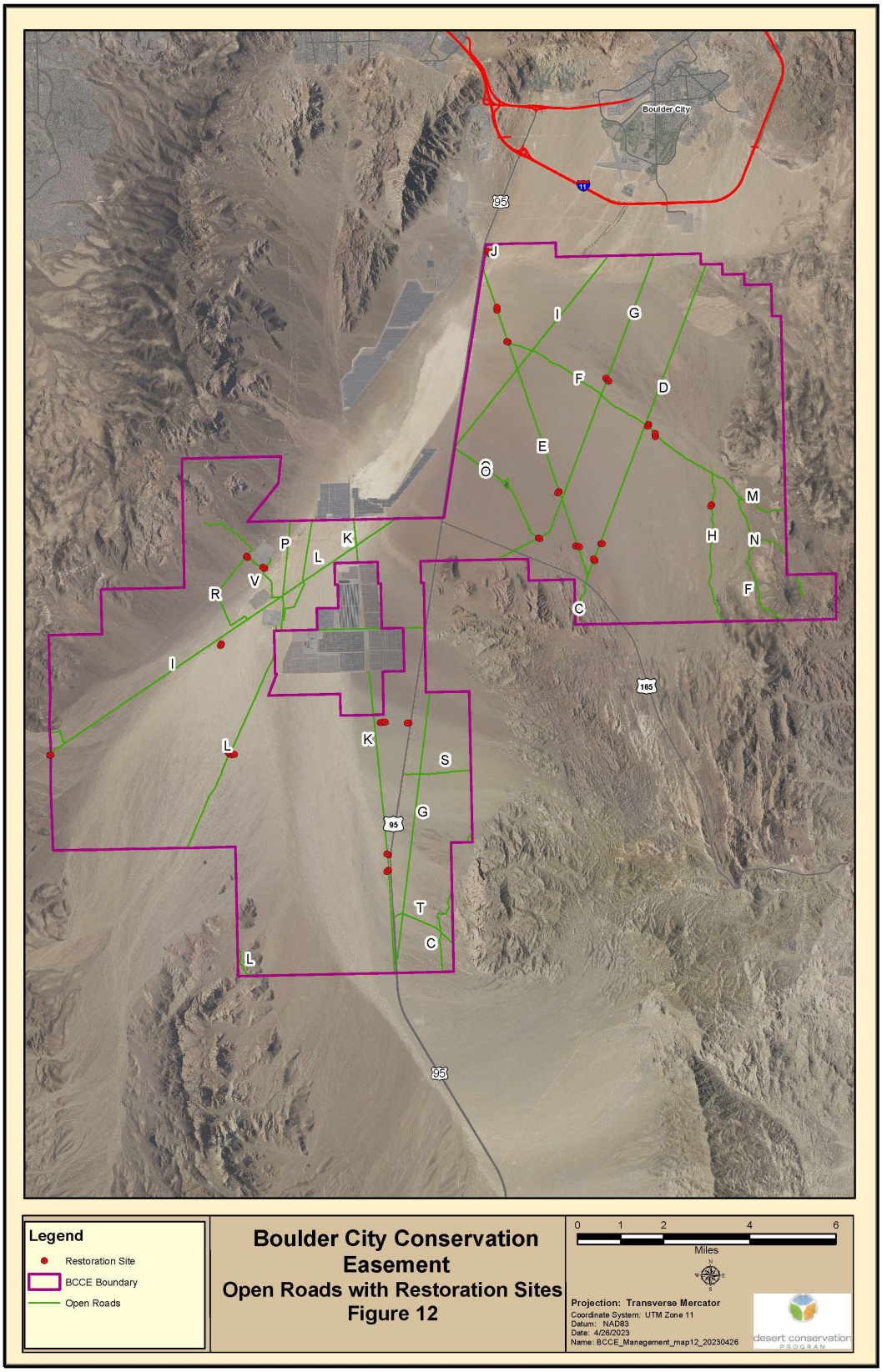


Figure 12 Restoration Sites

Predation

Predation is defined as the mortality of wildlife by species other than humans. Natural predation rates are not considered a stressor; however, current predation has been enhanced by increased populations of predators through changes in trophic structure, increases in food and water sources and nesting substrates (billboards, utility towers, buildings), and introduction of non-native predators (Boarman et al. 2006). Subsidized predators include native species such as the common raven (), which is the most well-documented subsidized predator in the Mojave Desert, and the coyote (), as well as introduced species such as dogs (*Canis familiaris*) and cats (*Felis catus*). Raven predation of juvenile desert tortoises has been well documented (USFWS 2011). The contribution of predation to the survivorship and demographic impacts of desert tortoises have not been quantified and is complicated by spatial and temporal variability and difficulty of monitoring juvenile tortoises (USFWS 2011). A recent project has surveyed for the extent of predation pressure in the BCCE and found that it is largely restricted to the area south of Boulder City (Boarman et al. 2018).

Management recommendations include reducing predator subsidies of trash and open water. Across the full BCCE, predation is currently assumed to be a moderate stressor.

2.5 Public Services and Safety

Public services and safety address agencies responsible for utilities on and across the BCCE, emergency response within the BCCE and surrounding areas, and safety procedures followed by DCP and contractors that access the BCCE. Since the BCCE is located within the jurisdiction of Boulder City, public safety services are provided by the City agencies. Agency contacts and telephone numbers are listed in Appendix G.

2.5.1 Fire and Medical

Boulder City Fire Department provides fire protection and emergency medical response for the BCCE. The Department maintains mutual aid contracts with surrounding fire departments, including the County and Henderson, as well as with BLM and NPS. BLM and NPS law enforcement rangers and fire crews are responsible for fire and medical emergency response on BLM and NPS lands.

2.5.2 Law Enforcement

Boulder City Police Department is the agency providing police protection to the BCCE. Law enforcement on the BCCE is an important management objective addressed by the DCP, and it is required by both the Grant and the incidental take permit. The DCP has contracted for law enforcement on the BCCE since February 2000 to ensure that the public complies with the uses outlined in the Grant. As representatives of the DCP and the County, law enforcement personnel also serve a role in public relations and conservation education. As a result, emphasis is placed on helping the public understand the purpose for the BCCE, its importance as a reserve for covered species, and uses that are allowed and prohibited.

Boulder City is responsible for enacting and enforcing codes and ordinances for public land uses that are necessary to permit allowable uses and enforce prohibited uses on the BCCE. The City allows peace officers provided by DCP to issue citations to BCCE users violating City Code 7-5-8, Prohibited Uses within the Eldorado Valley Transfer Area; however, citations are rarely issued and generally to flagrant or repeat offenders only. The City is also responsible for providing officers to monitor activities that it permits on the BCCE and to cite and prosecute violators of permits.

A summary of law enforcement activities that occur on the BCCE are submitted to DCP on a weekly basis. The summary report is reviewed to monitor the type, frequency, and location of violations, and integrate the findings to adaptively manage the BCCE. Since DCP is responsible for enforcing the terms of the Grant, the data help focus law enforcement efforts to the areas where most violations take place, and attempt to reduce infractions over time.

Nevada Highway Patrol enforces traffic regulations on US 95 and SR 165. BLM and NPS law enforcement rangers patrol federal lands and are responsible for protecting the resources, preventing illegal dumping, and enforcing traffic codes on BLM and NPS lands.

2.5.3 Utilities

There are no requirements for utilities to manage the BCCE for conservation purposes, although some public utilities are available in the area. Potable water service to the energy facilities in the Energy Zone and on the BCCE is provided by the City and it is distributed via an underground water main that parallels Eldorado Valley Drive. There is no municipal sanitary sewer collection service provided to the Eldorado Valley; facilities have septic tanks and drain (i.e., leach fields) for wastewater treatment and disposal needs. The energy facilities provide for their own electricity needs. An underground natural gas pipeline owned by Southwest Gas Corporation crosses the BCCE from south to north. Fiber optic cables and telecommunications are located underground and parallel Eldorado Valley Drive.

The Boulder City Wastewater Treatment Plant is located a little over a mile north of the North Section of the BCCE (Figure 4). The City retained limited rights in the Grant to allow treated effluent from the plant to discharge onto the BCCE.

2.5.4 Safety

The DCP follows standard health and safety procedures for working in the desert environment, including guidelines for weather-related risks and biological hazards (snakes, insects). Emergency contact is provided through 911 service; non-emergency support is requested by dialing 311. Cell phone service is available on and near the BCCE through most telecommunication carriers. A list of contacts for management, safety, and services is provided in Appendix G.

The DCP has established procedures to minimize exposure to naturally occurring asbestos fibers that could be present in airborne dust. Procedures were developed with the assistance of the Clark County Department of Air Quality and with references from the Environmental Protection Agency and the Agency for Toxic Substances and Disease Registry. The procedures address measures to minimize staff exposure and reduce the spread of fibers that may be on field clothes, equipment, and vehicles. The procedures described here are intended to reduce risk of exposure to naturally occurring asbestos fibers.

Procedures for digging or working in the ground:

- Always thoroughly wet the ground where working to prevent dust (a watering can used for plants should be sufficient).
- When digging or pounding items into the ground, always make sure the area is wet to prevent dust.

Section 3 Management Goals, Objectives, and Actions

The management goals for the BCCE are based on the Section 10 incidental take permit (USFWS 2001) and the guiding documents for the easement (Section 1.2).

3.1 Management Goals and Objectives

Management goals are broad, general statements to establish the direction for the management of the easement. **Management objectives** provide further explanation regarding the intent of the management goals and are established to measure progress towards achieving management goals for the BCCE. Management goals and objectives are presented in

Table 4. These management goals and objectives are related to, but not identical to, the Biological Goals and Objectives (BGO) that were drafted in 2016 (Clark County 2016, 2023). The BGOs are used to quantitatively gauge implementation and success of specific projects conducted under the MSHCP. Specific management actions (Section 3.2) are linked to both the management goals and objectives as well as the biological goals and objectives.

Table 4 BCCE Management Goals and Objectives

Goal 1	**Protect and manage the BCCE for the desert tortoise and its habitat.**
Objectives	*1.0 Restore and enhance desert tortoise habitat and monitor desert tortoise populations on the BCCE.*
	2.0 Install and maintain infrastructure that controls tortoise
	3.0 Identify and decrease direct stressors to desert tortoise, as needed.
Goal 2*	**2.0 Protect and manage the BCCE for other MSHCP covered**
Goal 3	**3.0 Manage the property and public uses to meet conservation obligations and legal**
Objectives	*4.0 Promote a road network that supports conservation and provides appropriate access for*
	5.0 Provide law enforcement.
	6.0 Control invasive plant species and noxious weeds.
	7.0 Promote responsible recreation and inform the public
	8.0 Manage allowable uses.
	9.0 Manage prohibited uses (Appendix C).
** There are no specific management objectives for this goal at this time because the BCCE is protected and managed for the desert tortoise. As concepts from the Adaptive Management and Monitoring Plan (AMMP, Alta 2023) are further integrated into BCCE Management Plan, specific objectives for this goal will be developed.*	

3.2 Discussion of Management Objectives and List of Management Actions

Management objectives guide identification and development of management actions and ongoing activities. **Management actions** are defined as specific actions, methods, or tools by which management objectives are met and management goals are achieved. Actions make up the "how do we get there" part of the planning process and are linkages between the Plan and implementation. This section provides a general discussion of each management objective and lists management actions that would meet each objective.

Section 3.3 contains the table of management actions with further details on what, where, when, and who implements each action, and how to measure effectiveness of implementation of the action.

Objective 1.0 - Restore and enhance desert tortoise habitat, and monitor desert tortoise populations on the BCCE

The primary purpose for establishing the easement was to manage and protect habitat for desert tortoise. The incidental take permit also states that, within the easement, connectivity for desert tortoise and other covered species should be maintained. Restoring closed roads and trails and enhancing areas of degraded or marginal habitat provides additional habitat for covered species. Priority should be given to closed roads and degraded habitat in areas within the BCCE where desert tortoises have been recently documented.

Culverts and other drainage structures under roadways can provide an avenue for connectivity between different areas of the Eldorado Valley and sections of the BCCE that are separated by infrastructure and tortoise exclusion fences. Opportunities to reestablish connectivity should be explored.

Management actions that will restore and enhance desert tortoise habitat include:

1.1 Evaluate and monitor the easement for changes in quality or extent of suitable tortoise habitat

1.2 Monitor desert tortoise occupancy and health of population, as possible

1.3 Identify and prioritize locations for habitat restoration and enhancement

1.4 Identify and implement restoration/enhancement plans for priority locations

1.5 Monitor and adaptively manage restoration/enhancement

Objective 2.0 - Install and maintain infrastructure that controls tortoise movement

Fences, road crossing guards, and gates eliminate or minimize the mortality of tortoises by preventing access onto roadways and by keeping vehicles on roadways and off habitat. Construction and maintenance of tortoise exclusion fences along major roads is a non-discretionary requirement in managing the BCCE as a condition of the incidental take permit. Tortoise exclusion mesh was added to the NDOT fences that parallel US 95 and SR 165, and gates and/or crossing guards are installed at right-of-way access locations. NDOT and DCP is responsible for monitoring and maintaining these fences, crossing guards, gates, and the drainage culverts.

The exterior of the BCCE boundary is not fenced and allows for tortoise passage and connectivity with adjacent lands. Unimproved roads within the BCCE do not experience sufficient traffic or speed to warrant tortoise protective barriers. The solar arrays within the

BCCE are surrounded by tortoise exclusion fencing, and protective fences exist along Eldorado Valley Drive in the vicinity of the Solar Energy Zone.

Management actions that will control tortoise movement include:

- 2.1 Inspect tortoise fences, road crossing guards, gates, and culverts for maintenance needs
- 2.2 Conduct emergency repairs and/or schedule maintenance repairs
- 2.3 Notify NDOT for highway fence repairs and culvert cleaning/maintenance
- 2.4 Install new or replace tortoise fences, road crossing guards, and gates as needed

Objective 3.0 - Identify and decrease direct stressors to desert tortoise, as needed

There are a number of direct and indirect stressors to the desert tortoise (Section 2.4.4) that affect management of the BCCE. Some stressors, such as recreation and development, are managed indirectly by addressing other objectives and management actions. Potential harm from predation has become an immediate concern. Future actions may be warranted to address additional direct stressors if they increase significantly.

Management actions that will address predation stressors include:

- 3.1 Monitor presence of predators to determine need for control
- 3.2 Implement effective predator control techniques, as appropriate, following federal, state, and county permits and guidelines

Objective 4.0 - Promote a road network that supports conservation and provides appropriate access for management and public use

Vehicle use and maintenance of designated and signed roads and trails are allowed on the BCCE. The roads in the BCCE typically experience reduced traffic flow and lower speeds are a minimal stressor to desert tortoises. None-the-less, closing roads and reducing traffic speed provides additional habitat and reduces habitat fragmentation, thus providing further protection. Additionally, closing roads reduces public access to sensitive areas of the BCCE, further reducing human stressors on the species and its habitat.

DCP is responsible for a) reviewing the earlier interim road designations and b) making adjustments to open and closed travel routes based on origins and destinations within the BCCE and on adjacent lands, usage, substrate (surface soils and desert washes) and physical condition, and existing rights-of-way.

DCP tracks and monitors the development of emerging technologies such as uncrewed aerial vehicle technology and wildlife cameras for monitoring road use by people and wildlife, and detecting and mapping unauthorized use (e.g., initiation of social routes). Use of uncrewed aerial vehicle technology in the BCCE has been discussed and will continue if there is continued interest. Wildlife cameras could be used for monitoring wildlife movements in and around culverts, roads, and restoration areas.

Management actions that will manage the road network include:

- 4.1 Inventory and identify (name) open and closed roads digitally (e.g., Google Maps) and with signage within the BCCE
- 4.2 Identify,prioritize, and implement road closures
- 4.3 Develop restoration plans for permanently closed roads

4.4 Implement and monitor restoration of closed roads

Objective 5.0 - Provide law enforcement

Providing law enforcement is a non-discretionary requirement of managing the BCCE as a condition of the incidental take permit. Law enforcement has two roles: to educate the public about the purpose of the easement and allowable uses, and to protect the easement from unauthorized uses. Boulder City Police Department provides peace officers to patrol the BCCE in close coordination with DCP to best address effectiveness of patrols in fulfilling conservation obligations of the easement.

Management actions that will address law enforcement include:

5.1 Maintain patrols by Boulder City peace officers

5.2 Monitor and adjust patrol schedule and locations

5.3 Monitor and enforce prohibited uses

5.4 Evaluate officer/public contacts for opportunities to improve patrols

Objective 6.0 - Control invasive plant species and noxious weeds

One of the most destructive stressors on the Mojave Desert ecosystem is fire. Fires reduce or eliminate desert shrubs and herbaceous diversity and thus reduce structure and food resources. Frequency of fire in the Mojave Desert is related to the increase in fine fuels, the source of which is generally non-native invasive plant species. These invasive species also compete with native herbaceous species. The DCP, as a landowner, is required by the NRS to control the spread of noxious weeds. Most likely locations for invasive plant species and noxious weeds are along roadways, but systematic assessments of areas away from roads should be considered. While there is no evidence that invasive plant species and noxious weeds are degrading habitat or in densities that provide fuel for fire on the BCCE, it is important to be proactive in inventory and control.

Management actions that will control invasive plant species and noxious weeds include:

6.1 Identify and treat (eradicate or reduce) locations infested or susceptible to invasive plants and noxious weeds

6.2 Monitor locations for recurrence of invasive plants and noxious weeds

Objective 7.0 - Promote responsible recreation and inform the public on current activities

It is important to achieving conservation obligations to ensure that the public and users of the BCCE understand the purpose of the easement, know allowable and prohibited uses on the property, and can locate the physical extent (boundaries) of the BCCE. Information can be provided through signage, interpretive materials, kiosks, and the DCP webpage.

Management actions that will educate the public on allowable uses and current activities include:

7.1 Establish and maintain a consistent brand and design for signs, kiosks, interpretive materials, brochures, and webpage

7.2 Identify locations and maintain database for signs and kiosks

7.3 Post and maintain condition of all easement boundary signs, “Limited Use Area” signs, interpretive signs, and kiosks

7.4 Develop content, print, and distribute interpretive brochure(s) to users of the BCCE

7.5 Update information on BCCE webpage

Objective 8.0 - Manage allowable uses

Section 2 of the Grant states that use of the property is allowed for only such activities which do not impair the conservation, protection, restoration, and enhancement of the natural resource values of the property (Appendix A). Allowable uses include reserved rights (Section 6 of the Grant) that are compatible with the purpose of the Grant, such as non-consumptive recreational activities, maintenance and construction of utilities and ancillary structures, and discharge of treated wastewater effluent. Other allowable uses with permission from the City, DCP, and/or USFWS include exemptions to prohibited uses.

Management actions that will ensure DCP identifies and manages allowable uses of the BCCE include:

8.1 Monitor condition of three historic sites located on the BCCE

8.2 Maintain relationships and coordinate with adjacent landowners to protect conservation values of the BCCE

8.3 Monitor and coordinate with utility companies to minimize impacts from existing and proposed transmission corridors and facilities

8.4 Review exceptions to prohibited uses (i.e., discharge of firearms) for conflicts with Boulder City Code and Ordinances and Nevada hunting regulations

8.5 Monitor location and effects of treated effluent discharge

Objective 9.0 - Manage prohibited uses

Section 4 of the Grant states that any activity that is incompatible with the purpose of the easement is prohibited and lists a number of activities on and uses of the property that are not allowed.

Prohibited uses include, with limited exceptions, surface disturbances, motorized vehicle use off designated roads, grazing, commercial or non-commercial collection of flora and fauna, dumping and littering, application of herbicides or biocides, release of captive or displaced tortoises, uncontrolled dogs outside of vehicles, and discharge of firearms. Continued use of the pet cemetery is no longer allowed. Many of these prohibited uses are curtailed by the presence of law enforcement and through monitoring by DCP staff.

The management actions that will manage prohibited uses of the BCCE include:

9.1 Review and revise easement documents for conflicting uses and restrictions with Boulder City Code

9.2 Maintain fence and gate installed around pet cemetery

9.3 Monitor for burial of animal remains outside the fenced pet cemetery area

9.4 Monitor known and potential locations of illegal dumping activity

9.5 Remove trash and debris from illegal dump sites

9.6 Monitor for other prohibited uses

9.7 Install new fences and/or barriers to prohibit access of OHV into unauthorized areas

9.8 Contact or have law enforcement contact businesses operating within the easement without the proper permits

3.3 Management Actions and Effectiveness Measures

The primary purpose of a management plan is to provide guidance for selecting management actions that support or meet management objectives, and ultimately achieve management goals. The management actions for the BCCE have been identified from regular management operations, as well as other actions necessary to meet the objectives and goals for managing the BCCE.

The following table includes the management objectives (noted as 1.0, 2.0, etc.) and the management actions (1.1, 1.2, 2.1, etc.) related to each management objective. Management actions can be separate individual activities or be interrelated with other actions and sequential in implementation.

Each management action is presented in the following table by the columns that include:

- **Management Action Description**: a brief description of what the action entails and why it is important.
- **Effectiveness Measures**: a listing of metrics to be measured to assess the effectiveness (success) of the management action.

These management actions are reported on quarterly in the BCCE Management Actions Tracking Table in each Quarterly Administers Update (https://www.clarkcountynv.gov/government/departments/environment_and_sustainability/desert_conservation_program/plan_administrator_updates.php). Details on the management actions' location, timeframe, related permits, cost, and status can be found in annual or project reporting, The management action table is a tool to guide management activities and is intended as a working document for the DCP to update, add to, and/or change actions as conditions warrant.

Each update to the table should be tracked by entering a current date in the footer of the table.

Table 5 Management Plan Goals, Objectives, Description, and Effective Measures

BCCE Management Goals and Objectives		Management Action Description	Effectiveness Measures
1	**Restore and enhance desert tortoise habitat, and monitor desert tortoise populations on the BCCE**		
1.1	Evaluate and monitor the easement for changes in quality or extent of suitable tortoise habitat	Monitor BCCE suitable tortoise habitat for changes over time.	Protect, restore, or otherwise increase the quality and quantity of desert tortoise habitat.
1.2	Monitor desert tortoise occupancy and heath of tortoise population, as possible	Monitor occupancy for changes over time. This can be used as effectiveness monitoring for other projects as well as a way to evaluate changes to the tortoise population.	Desert tortoise population on the BCCE remains stable or increases.
1.3	Identify and prioritize locations for habitat restoration and enhancement	Prioritize locations for restoration and enhancement using the work completed through the occupancy sampling project and other ongoing habitat monitoring efforts.	Areas for restoration and enhancement are identified and prioritized.
1.4	Identify and implement restoration/enhancement plans for priority locations	Use results from 1.3 to plan location, type, and extent of restoration/enhancement	Plans meet restoration goals and objectives, contract requirements, and are ready for implementation
1.5	Monitor and adaptively manage restoration/enhancement	Establish success criteria and monitoring schedule; assess success of restoration/enhancement against criteria; continue/augment restoration actions to maintain investment	Restoration/enhancement plantings and topographic modifications meet success criteria
2	**Install and maintain infrastructure that controls tortoise movement**		
2.1	Inspect tortoise fences, road crossing guards, gates, and culverts for maintenance needs	Schedule and conduct periodic inspections of infrastructure; conduct inspections when opportunities arise or in conjunction with other activities	Location, length, and percent of tortoise fencing, road crossing guards, gates, and culverts inspected. Number, length, and percent of fencing, protective gates, and culverts needing repair
2.2	Conduct emergency repairs and/or schedule maintenance repairs	DCP staff can repair minor fence damage; contact NDF to schedule maintenance/repairs	Completion of repairs, time period between notification and repair

Table 5 Management Plan Goals, Objectives, Description, and Effective Measures

2.3	Notify NDOT for highway fence repairs and culvert cleaning/maintenance	Call NDOT point of contact to request maintenance crew; provide location and type of repair/maintenance needed	Completion of repairs, time period between notification and repair
2.4	Install new or replace tortoise fences, road crossing guards, and gates as needed	Complete installations.	Completion of installation, time period between notification and installation is minimized.
3	**Manage direct stressors to desert, as needed**		
3.1	Identify and monitor presence of predators to determine need for control	Implement relevant predator studies.	Determine the extent/degree of predation which occurs on desert tortoise in the BCCE.
3.2	Implement effective predator control techniques, as appropriate, following federal, state, and county permits and guidelines	Review results from relevant predator studies or monitoring efforts in the region to assess the need for predator control efforts.	Techniques are practicable and feasible with measurable benefits.
4	**Manage road network to support conservation and provide appropriate access for management and public use**		
4.1	Inventory and identify (name) open and closed roads digitally (e.g., Google Maps), and with signage within the BCCE		Roads are accurately labeled.
4.2	Identify, prioritize, and implement road closures	Use results from 4.1, 5.3, and other criteria to identify roads for closure	Prioritized road closures
4.3	Develop restoration plans for permanently closed roads	Based on results of 4.4, prepare plan(s) to restore road to native habitat or hide/mask road presence; determine length of road to restore using data from 4.1 and 5.3; establish success criteria	Plans are completed with goals and objectives for restoration and with all components needed for implementation
4.4	Implement and monitor restoration of closed roads	Establish success criteria and monitoring schedule; assess success of restoration/enhancement against criteria; continue/augment restoration actions to maintain investment	Restoration/enhancement plantings and topographic modifications meet success criteria
5	**Provide law enforcement**		
5.1	Maintain patrols by Boulder City peace officers	Maintain and renew contract in accordance with Section 5(c) of 2010 grant amendment	Funding for law enforcement included in biennial budgets
5.2	Monitor and adjust patrol schedule and locations	Review patrol reports from peace officers; adjust patrols based on season, public contacts, infractions, and discussions with officers	Assess hours, locations, and contacts; compare to public usage

Table 5 Management Plan Goals, Objectives, Description, and Effective Measures

5.3	Monitor and enforce prohibited uses	Review patrol reports from peace officers for number, frequency, and type of prohibited use	Number and trend of prohibited uses addressed by law enforcement
5.4	Evaluate officer/public contacts for opportunities to improve patrols	Review patrol reports and discuss the type, frequency, and location of public contacts with officers; update officers on DCP ongoing activities and public outreach/education initiatives	Measures of more effective patrols: contacts, elimination or reduction of problems/issues
6	**Manage property to control invasive plant species and noxious weeds to reduce fire stress on the ecosystem**		
6.1	Identify and treat (eradicate or reduce) locations infested or susceptible to invasive plant species and noxious weeds	Complete weeds assessment; record locations, identify species of concern	Assess areas surveyed and areas where invasive plant species and noxious weeds were found
6.2	Monitor locations for recurrence of invasive plant species and noxious weeds	Establish monitoring schedule; assess success of treatment/eradication against criteria; schedule additional treatments as needed	Monitor to area and/or numbers to assess eradication or reduction; eradication success is no or minimal recurrence of species
7	**Educate the public on allowable uses and current activities**		
7.1	Establish and maintain a consistent brand and design for signs, kiosks, interpretive materials, brochures, and webpage		
7.2	Identify locations and maintain database for signs and kiosks	Create/update inventory/database of locations of existing signs and markers; review recommendations of branding/interpretive planning master plan report (2011-LGA- 910C); select preferred locations for interpretive signs/kiosks	Locations for signage identified and approved; inventory/database updated
7.3	Post and maintain condition of all easement boundary signs, “Limited Use Area” signs, interpretive signs and kiosks		Inspect all signage at regular intervals, and repair in a timely manner.
7.4	Develop content, print, and distribute interpretive brochure(s) to users of the BCCE	Prepare scope of work and contract; identify locations to distribute brochures; provide brochures to Boulder City peace officers	Brochures printed and meet the contract requirements, maintain distribution to users, assess where and who uses brochures

Table 5 Management Plan Goals, Objectives, Description, and Effective Measures

7.5	Update information on BCCE webpage	Use results from 9.1 to review, confirm accuracy, and update information on Boulder City code/ordinances, use results from 4.4 to update road information and map	Information is accurate and updated
8	**Manage allowable uses**		
8.1	Monitor condition of three historic sites located on the BCCE	Photo document condition of sites; establish schedule to monitor condition; develop plan of action if sites degrade or are vandalized	Develop metrics to measure condition of historic sites
8.2	Maintain relationships and coordinate with adjacent landowners to protect conservation values of the BCCE	Establish schedule to communicate (formal and/or informal, as appropriate) with landowners on BCCE management actions, issues, and ongoing and pending projects	Relationships with adjacent landowners is reviewed annually
8.3	Monitor and coordinate with utility companies to minimize impacts from existing and proposed transmission corridors and facilities	Identify representatives for utility companies on, adjacent, or crossing BCCE (request assistance from Boulder City and/or BLM, if necessary); establish schedule to communicate (formal and/or informal, as appropriate) with representatives to exchange information	Coordination and success of minimizing impacts is reviewed annually
8.4	Review exceptions to prohibited uses (discharge of firearms) for conflicts with Boulder City Code and Ordinances and Nevada hunting regulations	Review seasonal exception for discharge of firearms for hunting/trapping against seasonal NV hunting regulations for possible conflicts, and against Boulder City Code 7- 1-3 for restricted distances; determine corrective action if conflicts exist	Possible conflict confirmed and resolved
8.5	Monitor location and effects of treated effluent discharge	Establish schedule to monitor condition and location of discharge; photo document condition of discharge channel; develop plan of action if discharge channel creates nuisance and/or undesirable habitat	Develop metrics to measure change in topography and vegetation
9	**Manage prohibited uses**		
9.1	Review and revise easement documents for conflicting uses and restrictions with Boulder City Code		
9.2	Maintain fence and gate installed around pet cemetery	Schedule inspections to monitor and maintain condition of fence and gate; repair and/or schedule repairs when damage is observed	Fence and gate maintained and repaired within a week of discovered damage
9.3	Monitor for burials of animal remains outside the fenced pet cemetery area	In conjunction with 9.1, monitor for burial activity outside fenced area; identify options to safely remove and location(s) for disposal of buried remains	Record all burials outside of fenced pet cemetery within a week of discovery

Table 5 Management Plan Goals, Objectives, Description, and Effective Measures

9.4	Monitor known and potential locations of illegal dumping activity	Establish schedule to regularly monitor locations of past dumping activities	Location of trash and debris is known, leading to 9.5
9.5	Remove trash and debris from illegal dump sites	Establish procedure and/or contract to safely remove materials from dump sites for disposal at appropriate landfill (construction debris, household trash, hazardous waste)	Trend toward less trash and debris in the BCCE
9.6	Monitor for other prohibited uses	In conjunction with inspections/monitoring of other actions, monitor site conditions and user activities for prohibited conduct; coordinate with Boulder City peace officers on observations and findings	Trend toward fewer prohibited actions in the BCCE
9.7	Install new fences and/or barriers to prohibit access of OHV into unauthorized areas	In conjunction with inspections/monitoring of other actions, monitor site conditions and user activities for prohibited conduct; coordinate with Boulder City peace officers on observations and findings	Trend toward fewer prohibited actions in the BCCE
9.8	Contact or have law enforcement contact businesses operating within the easement without the proper permits	Monitor site conditions and user activities for prohibited conduct; coordinate with Boulder City peace officers on observations and findings	Trend toward fewer prohibited actions in the BCCE

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Appendix A

Amended Interlocal Agreement, Conservation Easement Grant

The original 1994 Interlocal Agreement and Conservation Easement Grant is available at: https://files.clarkcountynv.gov/clarknv/1995%20bcce%20easement%20with%20atts.pdf?t=1616563076766&t=1616563076766

The 2010 amendment to the Interlocal Agreement and Conservation Easement Grant is available at: https://files.clarkcountynv.gov/clarknv/Environmental%20Sustainability/Desert%20Conservation/Forms%20and%20Attachments/20100803%20BCCE%20amendment%20with%20sigs.pdf?t=1616563076766&t=1616563076766

Appendix B
BCCE Expansion and Exchange Criteria

BCCE Expansion and Exchange Criteria

Any Future land expansion of the BCCE will consider the following criteria:

1. **Undeveloped Habitat Suitable for Desert Tortoise**

   Potential expansion areas should include more than 75 percent undeveloped habitat that is suitable for desert tortoise.

2. **Contiguity with the BCCE**

   Potential expansion areas should be either adjacent to the BCCE or adjacent to public lands that are also dedicated to habitat protection for tortoise, other wildlife, or plants, and also border the BCCE.

Any future requests to exchange areas within the BCCE will consider the following criteria:

1. **Quality of Desert Tortoise Habitat**

   Relative quality of desert tortoise habitat for all parcels in consideration shall be evaluated by conducting 100 percent coverage surveys in accordance with the most recent U.S. Fish and Wildlife Service (USFWS) pre-project field survey protocols for potential desert tortoise habitats. The goal of performing 100 percent coverage surveys is to compare the relative abundance of desert tortoise populations amongst all parcels proposed for land swap.

2. **Functional Size of Desert Tortoise Habitat**

   Is the area contiguous with other lands protected for tortoise? Does it meet minimum size and population requirements for an adequate reserve as defined in the revised recovery plan? Is the functional size of the land proposed for swap greater or lesser than the functional size of the habitat that DCP would be exchanging?

3. **Review for the Presence of Other Covered Species**

   The proposed exchange land should be reviewed for suitable habitat or known occurrences of other species covered by the MSHCP, or those recommended for coverage under a proposed amendment to the MSHCP.

4. **Equal or Lower Level of Habitat Fragmentation**

   Review proposed parcels for habitat fragmentation with consideration for roads, utility corridors, or other land disturbances that reduce the available habitat for desert tortoises. Review The Nature Conservancy's habitat intactness model, and determine if the proposed exchange land more or less intact.

5. **Ease of Management**

   Considerations should include BLM corridors, rights-of-way, mining claims, or other similar encumbrances that would make management of the area for the protection of desert tortoises more difficult. Also consider accessibility of the property, and any modifications required to secure the property.

6. **Equal or Greater Level of Habitat Protection**

   Is the land proposed for exchange currently managed by another agency and would they retain management of the area following the exchange? What is the land use

designation of the proposed exchange property? Can we ensure durability of mitigation actions?

7. Evaluate Proposed Land Exchanges for Loss of Mitigation Actions

Evaluate the land that DCP would be giving up for potential loss of mitigation actions. Examples of the types of mitigation actions that may be affected by proposed land swaps include: road closures and restoration, non-native weed survey and treatment, purchase of grazing allotments, etc. Can the cost of mitigation actions that would be lost be quantified?

8. Evaluate the Proposed Land Exchange for Loss of Long-term Study Areas

Are there long-term study areas/plots that would be lost through the proposed exchange? What ongoing project would be affected by the proposed exchange?

Appendix C
Restricted Activities and Required Approvals

Grant Section	Restricted Activity or Use	Requires Approval From
3(d)	Construction of trails, access facilities, or improvements	Boulder City, USFWS
4(a)	All motorized vehicle activities off designated roads and trails	Prohibited
4(a)	Competitive and organized motorized vehicle events on designated roads and trails	DCP, USFWS
4(b)	Military maneuvers, clearing for agriculture, landfills, and any other surface disturbance that diminish	Prohibited
4(c)	Grazing by cattle, horses, burros, and domestic sheep	Prohibited
4(d)	Commercial collection of flora and fauna	Prohibited
4(e)	Non-commercial collecting of flora	DCP, USFWS, Boulder City, relevant state/federal agencies
4(f)	Non-commercial collecting of fauna	DCP, USFWS, Boulder City, relevant state/federal agencies
4(g)	Dumping, disposal of refuse, littering	Prohibited
4(g)	Application of herbicides or biocides	Prohibited
4(h)	Release of captive or displaced desert tortoises or other animals, except as part of an authorized translocation program.	DCP, USFWS
4(i)	Uncontrolled dogs out of vehicles.	Prohibited
4(j)	Construction of any physical improvement	DCP, USFWS, Boulder City
4(k)	Discharge of firearms, except in conjunction with hunting or trapping from September to March	Prohibited
5(b)	Post signs on or about the BCCE for prohibited and permitted uses	DCP, Boulder City
6(a)(1)	Non-intrusive monitoring of desert tortoise populations and habitat	Boulder City
6(a)(2)	Travel on and maintain designated and signed roads and trails	Boulder City
6(a)(3)	Non-consumptive recreation including hiking, bird watching, bicycling, horseback riding, and photography	Boulder City
6(a)(4)	Parking and camping in designated areas	Boulder City, DCP, USFWS
6(a)(5)	Fire suppression	Boulder City
6(a)(6)	Approved or controlled maintenance of utilities and ancillary structures.	Boulder City
6(a)(7)	Surface disturbances that enhance quality of wildlife habitat, watershed protection, or improve opportunities for non- motorized recreation	Boulder City
6(a)(7)	Construction of visitor centers, wildlife water projects, and camping facilities.	Boulder City
6(a)(8)	Population enhancement of native species	Boulder City
6(a)(9)	Non-manipulative and non-intrusive biological or geological research (by written permit).	Boulder City
6(b)(1)	Discharge of treated wastewater effluent onto an area defined in Exhibit B to the 2010 Amendment	Boulder City, USFWS

Grant Section	Restricted Activity or Use	Requires Approval From
6(b)(2)	Construction of electrical, water, sewer, gas, drainage and other utilities to support the maintenance and operation of power generating facilities at sites within	Boulder City, USFWS
6(b)(2)	Implement best practices for construction, maintenance, and operation of infrastructure within the BCCE in accordance with Exhibit D to the 2010 Amendment	Boulder City, USFWS, DCP
6(b)(3)	Construction of utility transmission lines to connect federal utility corridors or a federal utility corridor to an existing electrical substation	Boulder City, USFWS
6(b)(3)	Implement best practices for construction, maintenance, and operation of infrastructure within BCCE in accordance with Exhibit D to the 2010 Amendment	Boulder City, USFWS, DCP

Appendix D
Permit Request Process

Requests for Third Party Activities on the Reserve Units

(Version 1_4, December 2012)

While the primary purpose of the Desert Conservation Program (DCP) reserve system properties is to provide mitigation for loss of covered species and their habitat, there are a variety of other allowable activities in the reserve system. The types of allowable uses vary among the reserve system properties as do requirements for formal, written permission for certain activities. In general, activities on DCP reserve properties that disturb the soil outside of open roads and trails, remove rocks, vegetation, seeds or require handling or removal of animals (including insects or spiders) require written permission from the County. The DCP does not process hunting requests but defers to Nevada Department of Wildlife permits, rules, and regulations. Hunting is allowed in the reserve system where allowable by state law and local ordinances.

Request Requirements

All requests must be made in writing or by email. Minimum request details include:

- Requestor name and contact info,
- Location of the activity,
- Date of the activity (range of dates is OK),
- Description and purpose of the activity,
- Description of any ground or species disturbance, and
- Description of collection of plant/animal/mineral or other materials.

Please complete and submit the attached form to DCP@ClarkCountyNV.gov but do not sign it. A signature will be requested from the applying party upon approval and will acknowledge any terms and conditions set forth by the DCP.

Notification

Approval or rejection of each request, along with any conditions on the request, will be provided to the requestor by email. Approval of a request will contain a signed copy of the following form and any terms and conditions set forth by the DCP. The actions requested are not completely approved until the requestor returns a copy of the form with their signature and date acknowledging acceptance of the Reserve Use Permission terms and conditions. Rejected applications will receive an email with a brief explanation as to why the application was rejected.

Request for Third Party Activities on the Reserve Units

Clark County Desert Conservation Program
4701 W Russell Rd, Suite 200
Las Vegas, NV 89118

dcp@ClarkCountyNV.gov
Phone (702)455-3536

Requestor's name, email, phone number(s) and mailing address:
Permission is sought for the undersigned to conduct the following activities. Requestor may also attach a summary or complete methods description. Activities:
Dates Requested:
Name of Desert Conservation Program Reserve:

This permission is not valid until a countersigned and dated copy of this form is received from the Clark County Desert Conservation Program. The undersigned shall indemnify, defend and hold harmless Clark County, Nevada and its officers, agents, and employees against any and all damages, claims, or causes of action arising from or in connection with the activities described on this form. The undersigned is responsible for compliance with all federal, state, and local laws, rules, and regulations and any terms and conditions attached to this Reserve Use Permission. A copy of the final form, including terms and conditions, must be with the undersigned at all times while conducting these activities on the reserve property.

Requestor's Signature Date

Department of Air Quality Director or Assistant Director Signature Date

Appendix E
NRCS Soil Types in the BCCE

NRCS Soil Types in the BCCE

Soil Series Name	Total Acres in the BCCE	Percent of Total Area in the BCCE	Landscape	Landform	Parent Material	Runoff	Flooding	Drainage Class
Tonopah-Arizo association	21,299	24.6	Fan Piedmont	Fan Remnants	Alluvium Derived from Mixed Sources	Low	Very Rare	Excessively Drained
Arizo association	19,255	22.2	Fan Piedmont	Fan Aprons	Mixed Alluvium	Low	Very Rare	Excessively Drained
Searchlight extremely gravelly sandy loam, 2 to 4 percent slopes	14,528	16.8	Fan Piedmont	Fan Aprons over Fan Remnants	Mixed Alluvium	Very Low	Rare	Well Drained
Hypoint gravelly sandy loam, 0 to 4 percent slopes	8,911	10.3	Piedmont	Fan Skirts	Mixed Alluvium	Very Low	Rare	Somewhat Excessively Drained
Arizo-Cafetal association	6,683	7.7	Fan Piedmont	Inset Fans	Mixed Alluvium	Low	Very Rare	Excessively Drained
Haleburu-Crosgrain-Rock outcrop association	4,886	5.6	Mountains	Backslopes of Mountains	Colluvium and/or Residuum Weathered from Volcanic Rock	Very High	None	Well Drained
Tipnat-Hypoint-Grapevine association	3,855	4.5	Bolson	Alluvial Flats	Mixed Alluvium	Low	Rare	Well Drained
Arizo-Tenwell association	2,239	2.6	Fan Piedmont	Inset Fans	Mixed Alluvium	Low	Very Rare	Excessively Drained
Nickel-Crosgrain association	2,083	2.4	Fan Piedmont	Summits of Fan Remnants	Mixed Alluvium	Very Low	None	Well Drained
Bluepoint-Tipnat-Grapevine association	849	1.0	Bolson	Sand Sheets	Eolian Sands	Negligible	Rare	Somewhat Excessively Drained

Soil Series Name	Total Acres in the BCCE	Percent of Total Area in the BCCE	Landscape	Landform	Parent Material	Runoff	Flooding	Drainage Class
Nipton-Haleburu-Rock outcrop association	605	0.7	Mountains	Northeast Facing Summits of Mountains	Colluvium and/or Residuum Weathered from Metavolcanics	Very High	None	Somewhat Excessively Drained
Haleburu-Hiddensun association	496	0.6	Mountains	Backslopes of Mountains	Colluvium and/or Residuum Weathered from Volcanic Rock	Very High	None	Well Drained
Haleburu association	364	0.4	Hills	Backslopes of Hills	Colluvium and/or Residuum Weathered from Volcanic Rock	Very High	None	Well Drained
Seanna-Goldroad-Rock outcrop association	158	0.2	Mountains	Backslopes of Hills and Mountains	Residuum Weathered from Granite	Very High	None	Well Drained
Seanna-Rock outcrop association	138	0.2	Mountains	Backslopes of Hills and Mountains	Residuum Weathered from Granite	Very High	None	Well Drained
Crosgrain very stony loam, 8 to 30 percent slopes	93	0.1	Fan Piedmont	Backslopes of Partial Ballenas	Mixed Alluvium Derived from Metamorphic Rock	Very High	None	Well Drained
Bluepoint loamy fine sand, 0 to 2 percent slopes	75	0.1	Basin Floor	Sand Sheets	Eolian Sands	Very Low	None	Somewhat Excessively Drained
Playas	14	0.0	Bolson	Playas	N/A	Negligible	N/A	N/A
Pits, gravel	9	0.0	Fan Piedmont	Fan Piedmont	N/A	N/A	N/A	N/A

Appendix F
Vegetation Inventory

The following table lists all vegetation species that have been inventoried within the BCCE. Vegetation surveys were conducted at 80 random locations across the BCCE from 2014-2016 and that information along with and other incidental observations during other projects were used in the creation of this list.

Plant Species of the Boulder City Conservation Easement					
Scientific Name[1]	Code[2]	Family[3]	Duration[4]	Habit[5]	Origin[6]
Yucca baccata	YUBA	Agavaceae	P	FHSSu	N
Yucca brevifolia	YUBR	Agavaceae	P	ST	N
Yucca schidigera	YUSC2	Agavaceae	P	FHST	N
Amaranthus blitoides	AMBL	Amaranthaceae	A	FH	I
Amaranthus fimbriatus	AMFI	Amaranthaceae	A	FH	N
Tidestromia oblongifolia	TIOB	Amaranthaceae	P	FHSSu	N
Amsonia tomentosa	AMTO2	Apocynaceae	P	FH	N
Asclepias erosa	ASER2	Apocynaceae	P	FHSu	N
Asclepias subulata	ASSU	Apocynaceae	P	FH	N
Acamptopappus shockleyi	ACSH	Asteraceae	P	Su	N
Acamptopappus sphaerocephalus	ACSP	Asteraceae	P	SSu	N
Adenophyllum cooperi	ADCO2	Asteraceae	P	Su	N
Adenophyllum porophylloides	ADPO	Asteraceae	P	Su	N
Ambrosia dumosa	AMDU2	Asteraceae	P	SSu	N
Ambrosia eriocentra	AMER	Asteraceae	P	SSu	N
Amphipappus fremontii	AMFR2	Asteraceae	P	S	N
Anisocoma acaulis	ANAC	Asteraceae	A	FH	N
Antheropeas lanosum	ANLA7	Asteraceae	A	FH	N
Antheropeas wallacei	ANWA	Asteraceae	A	FH	N
Artemisia ludoviciana	ARLU	Asteraceae	P	FHSu	I
Atrichoseris platyphylla	ATPL	Asteraceae	A	FH	N
Baccharis brachyphylla	BABR	Asteraceae	P	SSu	N
Baileya multiradiata	BAMU	Asteraceae	ABP	FH	N
Baileya pleniradiata	BAPL3	Asteraceae	ABP	FH	N
Bebbia juncea var. aspera	BEJUA	Asteraceae	P	SSu	N
Brickellia arguta	BRAR2	Asteraceae	P	SSu	N
Brickellia atractyloides	BRAT	Asteraceae	P	SSu	N

Scientific Name	USDA	Family	Duration	Habit	Origin
Brickellia desertorum	BRDE3	Asteraceae	P	SSu	N
Calycoseris wrightii	CAWR	Asteraceae	A	FH	N
Chaenactis carphoclinia	CHCA	Asteraceae	A	FH	N
Chaenactis fremontii	CHFR	Asteraceae	A	FH	N
Chaenactis macrantha	CHMA	Asteraceae	A	FH	N
Chaenactis stevioides	CHST	Asteraceae	A	FH	N
Chondrilla juncea	CHJU	Asteraceae	P	FH	I
Cirsium mohavense	CIMO	Asteraceae	ABP	FH	N
Cirsium neomexicanum	CINE	Asteraceae	BP	FH	N
Dicoria canescens	DICA4	Asteraceae	A	FH	N
Encelia farinosa	ENFA	Asteraceae	P	SSu	N
Encelia virginensis	ENVI	Asteraceae	P	S	N
Ericameria nauseosa	ERNA10	Asteraceae	P	SSu	N
Ericameria paniculata	ERPA29	Asteraceae	P	S	N
Erigeron divergens	ERDI4	Asteraceae	B	FH	N
Geraea canescens	GECA2	Asteraceae	A	FH	N
Glyptopleura marginata	GLMA2	Asteraceae	A	FH	N
Gutierrezia microcephala	GUMI	Asteraceae	P	SSu	N
Gutierrezia sarothrae	GUSA2	Asteraceae	P	FHSSu	N
Hymenoclea salsola	HYSA	Asteraceae	P	Su	N
Lactuca serriola	LASE	Asteraceae	AB	FH	I
Logfia californica	LOCA19	Asteraceae	A	FH	N
Logfia depressa	LODE9	Asteraceae	A	FH	N
Machaeranthera arida	MAAR5	Asteraceae	A	FH	N
Machaeranthera pinnatifida	MAPI	Asteraceae	P	FHSu	N
Malacothrix coulteri	MACO3	Asteraceae	A	FH	N
Malacothrix glabrata	MAGL3	Asteraceae	A	FH	N
Malacothrix sonchoides	MASO	Asteraceae	A	FH	N
Monoptilon bellidiforme	MOBE	Asteraceae	A	FH	N
Pectis papposa	PEPA2	Asteraceae	A	FH	N
Picrothamnus desertorum	PIDE4	Asteraceae	P	SSu	N
Porophyllum gracile	POGR5	Asteraceae	P	Su	N
Prenanthella exigua	PREX	Asteraceae	P	FH	N
Psathyrotes annua	PSAN	Asteraceae	AP	FH	N
Psathyrotes ramosissima	PSRA	Asteraceae	AP	FHSu	N
Psilostrophe cooperi	PSCO2	Asteraceae	P	FHSu	N
Rafinesquia neomexicana	RANE	Asteraceae	A	FH	N
Senecio flaccidus	SEFL3	Asteraceae	P	FHSu	N
Stephanomeria exigua	STEX	Asteraceae	ABP	FH	N
Stephanomeria pauciflora	STPA4	Asteraceae	P	FHSu	N
Stylocline micropoides	STMI2	Asteraceae	A	FH	N
Tetradymia axillaris	TEAX	Asteraceae	P	SSu	N
Thymophylla pentachaeta	THPE4	Asteraceae	P	FHSu	N

Scientific Name	USDA	Family	Duration	Habit	Origin
Uropappus lindleyi	URLI5	Asteraceae	A	FH	N
Viguiera parishii	VIPA14	Asteraceae	P	SSu	N
Xylorhiza tortifolia	XYTO2	Asteraceae	P	FHSu	N
Chilopsis linearis	CHLI2	Bignoniaceae	P	ST	N
Amsinckia menziesii	AMME	Boraginaceae	A	FH	N
Amsinckia tessellata	AMTE3	Boraginaceae	A	FH	N
Cryptantha angustifolia	CRAN4	Boraginaceae	A	FH	N
Cryptantha barbigera	CRBA5	Boraginaceae	A	FH	N
Cryptantha circumscissa	CRCI2	Boraginaceae	A	FH	N
Cryptantha confertiflora	CRCO12	Boraginaceae	P	FHSu	N
Cryptantha decipiens	CRDE	Boraginaceae	A	FH	N
Cryptantha dumetorum	CRDU	Boraginaceae	A	FH	N
Cryptantha gracilis	CRGR3	Boraginaceae	A	FH	N
Cryptantha holoptera	CRHO3	Boraginaceae	AP	FH	N
Cryptantha maritima	CRMA7	Boraginaceae	A	FH	N
Cryptantha micrantha	CRMI	Boraginaceae	A	FH	N
Cryptantha nevadensis	CRNE2	Boraginaceae	A	FH	N
Cryptantha pterocarya	CRPT	Boraginaceae	A	FH	N
Cryptantha recurvata	CRRE5	Boraginaceae	A	FH	N
Cryptantha sp.	CRYPT	Boraginaceae	-	-	N
Cryptantha utahensis	CRUT	Boraginaceae	A	FH	N
Cryptantha virginensis	CRVI5	Boraginaceae	BP	FH	N
Lappula occidentalis	LAOC3	Boraginaceae	AB	FH	N
Pectocarya heterocarpa	PEHE	Boraginaceae	A	FH	N
Pectocarya penicillata	PEPE26	Boraginaceae	A	FH	N
Pectocarya platycarpa	PEPL	Boraginaceae	A	FH	N
Pectocarya recurvata	PERE	Boraginaceae	A	FH	N
Pectocarya setosa	PESE	Boraginaceae	A	FH	N
Plagiobothrys jonesii	PLJO	Boraginaceae	A	FH	N
Tiquilia canescens	TICA3	Boraginaceae	P	Su	N
Tiquilia plicata	TIPL2	Boraginaceae	P	FHSu	N
Arabis pulchra	ARPU2	Brassicaceae	P	FHSu	N
Brassica juncea	BRJU	Brassicaceae	AP	FH	I
Brassica nigra	BRNI	Brassicaceae	A	FH	I
Brassica tournefortii	BRTO	Brassicaceae	A	FH	I
Chorispora tenella	CHTE2	Brassicaceae	A	FH	I
Descurainia pinnata	DEPI	Brassicaceae	ABP	FH	N
Descurainia sophia	DESO2	Brassicaceae	AB	FH	I
Dithyrea californica	DICA7	Brassicaceae	A	FH	N
Draba cuneifolia	DRCU	Brassicaceae	A	FH	N
Guillenia lasiophylla	GULA4	Brassicaceae	A	FH	N
Lepidium dictyotum	LEDI2	Brassicaceae	A	FH	N
Lepidium fremontii var. fremontii	LEFRF	Brassicaceae	P	SSu	N
Lepidium lasiocarpum	LELA	Brassicaceae	AB	FH	N
Lesquerella tenella	LETE3	Brassicaceae	A	FH	N

Scientific Name	USDA	Family	Duration	Habit	Origin
Malcolmia africana	MAAF	Brassicaceae	A	FH	I
Sisymbrium altissimum	SIAL2	Brassicaceae	AB	FH	I
Sisymbrium irio	SIIR	Brassicaceae	A	FH	I
Sisymbrium orientale	SIOR4	Brassicaceae	A	FH	I
Stanleya pinnata	STPI	Brassicaceae	P	FHSu	N
Streptanthella longirostris	STLO4	Brassicaceae	AB	FH	N
Thysanocarpus	THCU	Brassicaceae	A	FH	N
Buddleja utahensis	BUUT	Buddlejaceae	P	SSu	N
Cylindropuntia acanthocarpa	CYAC8	Cactaceae	P	S	N
Cylindropuntia bigelovii	CYBI9	Cactaceae	P	SSu	N
Cylindropuntia echinocarpa	CYEC3	Cactaceae	P	S	N
Cylindropuntia ramosissima	CYRA9	Cactaceae	P	S	N
Echinocactus polycephalus var. polycephalus	ECPOP	Cactaceae	P	S	N
Echinocereus triglochidiatus	ECTR	Cactaceae	P	S	N
Echinocereus engelmannii	ECEN	Cactaceae	P	S	N
Ferocactus cylindraceus	FECY	Cactaceae	P	S	N
Grusonia parishii	GRPA11	Cactaceae	P	S	N
Mammillaria tetrancistra	MATE4	Cactaceae	P	S	N
Opuntia basilaris var. basilaris	OPBAB2	Cactaceae	P	ST	N
Opuntia phaeacantha	OPPH	Cactaceae	P	S	N
Opuntia polyacantha	OPPO	Cactaceae	P	S	N
Sclerocactus johnsonii	SCJO	Cactaceae	P	S	N
Nemacladus glanduliferus var. orientalis	NEGLO	Campanulaceae	A	FH	N
Nemacladus sigmoideus	NESI	Campanulaceae	A	FH	N
Mortonia utahensis	MOUT	Celastraceae	P	S	N
Atriplex argentea	ATAR2	Chenopodiaceae	AP	FH	N
Atriplex canescens	ATCA2	Chenopodiaceae	P	S	N
Atriplex confertifolia	ATCO	Chenopodiaceae	P	SSu	N
Atriplex elegans	ATEL	Chenopodiaceae	AP	FH	N
Atriplex hymenelytra	ATHY	Chenopodiaceae	P	S	N
Atriplex polycarpa	ATPO	Chenopodiaceae	P	S	N
Chenopodium berlandieri	CHBE4	Chenopodiaceae	A	FH	N
Chenopodium incanum	CHIN2	Chenopodiaceae	A	FH	N
Chenopodium sp.	CHENO	Chenopodiaceae	-	-	-
Grayia spinosa	GRSP	Chenopodiaceae	P	SSu	N
Halogeton glomeratus	HAGL	Chenopodiaceae	A	FH	I
Krascheninnikovia lanata	KRLA2	Chenopodiaceae	P	SSu	N
Monolepis nuttalliana	MONU	Chenopodiaceae	A	FH	N
Salsola paulsenii	SAPA8	Chenopodiaceae	A	FH	I
Salsola tragus	SATR12	Chenopodiaceae	A	FH	I
Suaeda moquinii	SUMO	Chenopodiaceae	P	FHSSu	N
Cuscuta californica	CUCA	Cuscutaceae	P	FHV	N
Cuscuta sp.	CUSCU	Cuscutaceae	-	-	-

Scientific Name	USDA	Family	Duration	Habit	Origin
Ephedra aspera	EPAS	Ephedraceae	P	SSu	N
Ephedra nevadensis	EPNE	Ephedraceae	P	SSu	N
Ephedra torreyana	EPTO	Ephedraceae	P	SSu	N
Ephedra viridis	EPVI	Ephedraceae	P	S	N
Argythamnia neomexicana	ARNE2	Euphorbiaceae	AP	FH	N
Chamaesyce abramsiana	CHAB2	Euphorbiaceae	A	FH	N
Chamaesyce albomarginata	CHAL11	Euphorbiaceae	P	FH	N
Chamaesyce arizonica	CHAR18	Euphorbiaceae	P	FH	N
Chamaesyce micromera	CHMI7	Euphorbiaceae	A	FH	N
Chamaesyce polycarpa	CHPO12	Euphorbiaceae	AP	FH	N
Chamaesyce setiloba	CHSE8	Euphorbiaceae	A	FH	N
Croton californicus	CRCA5	Euphorbiaceae	P	FHSu	N
Tragia ramosa	TRRA5	Euphorbiaceae	P	FHSSuV	N
Astragalus layneae	ASLA8	Fabaceae	P	FH	N
Astragalus lentiginosus	ASLE8	Fabaceae	ABP	FHSSu	N
Astragalus nuttallianus	ASNU4	Fabaceae	AP	FH	N
Astragalus sabulonum	ASSA2	Fabaceae	AP	FH	N
Astragalus tephrodes	ASTE8	Fabaceae	P	FH	N
Dalea mollis	DAMO	Fabaceae	A	FHSu	N
Dalea mollissima	DAMO2	Fabaceae	AP	FH	N
Hoffmannseggia glauca	HOGL2	Fabaceae	P	FHSu	N
Lotus strigosus	LOST4	Fabaceae	A	FH	N
Lupinus agardhianus	LUAG	Fabaceae	A	FH	N
Lupinus flavoculatus	LUFL	Fabaceae	A	FH	N
Lupinus shockleyi	LUSH	Fabaceae	A	FH	N
Prosopis glandulosa	PRGL2	Fabaceae	P	ST	N
Psorothamnus fremontii	PSFR	Fabaceae	P	S	N
Psorothamnus polydenius	PSPO	Fabaceae	P	S	N
Senegalia greggii	SEGR4	Fabaceae	P	ST	N
Senna armata	SEAR8	Fabaceae	P	S	N
Erodium cicutarium	ERCI6	Geraniaceae	AB	FH	I
Erodium texanum	ERTE13	Geraniaceae	AB	FH	N
Eucrypta micrantha	EUMI2	Hydrophyllaceae	A	FH	N
Nama demissum	NADE	Hydrophyllaceae	A	FH	N
Nama pusillum	NAPU	Hydrophyllaceae	A	FH	N
Phacelia ivesiana	PHIV	Hydrophyllaceae	A	FH	N
Phacelia crenulata	PHCR	Hydrophyllaceae	A	FH	N
Phacelia fremontii	PHFR2	Hydrophyllaceae	A	FH	N
Phacelia neglecta	PHNE	Hydrophyllaceae	A	FH	N
Phacelia palmeri	PHPA13	Hydrophyllaceae	A	FH	N
Phacelia pulchella	PHPU	Hydrophyllaceae	A	FH	N
Phacelia rotundifolia	PHRO2	Hydrophyllaceae	A	FH	N
Phacelia vallis-mortae	PHVA2	Hydrophyllaceae	A	FH	N
Krameria erecta	KRER	Krameriaceae	P	SSu	N
Krameria grayi	KRGR	Krameriaceae	P	SSu	N

Scientific Name	USDA	Family	Duration	Habit	Origin
Hyptis emoryi	HYEM	Lamiaceae	P	S	N
Salazaria mexicana	SAME	Lamiaceae	P	S	N
Salvia columbariae	SACO6	Lamiaceae	A	FH	N
Salvia dorrii	SADO4	Lamiaceae	P	SSu	N
Androstephium breviflorum	ANBR4	Liliaceae	P	FH	N
Calochortus flexuosus	CAFL	Liliaceae	P	FHV	N
Eucnide urens	EUUR	Loasaceae	P	Su	N
Mentzelia affinis	MEAF2	Loasaceae	A	FH	N
Mentzelia albicaulis	MEAL6	Loasaceae	A	FH	N
Mentzelia involucrata	MEIN5	Loasaceae	A	FH	N
Mentzelia multiflora	MEMU3	Loasaceae	BP	FH	N
Mentzelia obscura	MEOB3	Loasaceae	A	FH	N
Mentzelia oreophila	MEOR3	Loasaceae	BP	FHSu	N
Mentzelia pterosperma	MEPT	Loasaceae	BP	FH	N
Mentzelia tricuspis	METR2	Loasaceae	A	FH	N
Petalonyx nitidus	PENI	Loasaceae	P	SSu	N
Petalonyx parryi	PEPA13	Loasaceae	P	SSu	N
Malva sp.	MALVA	Malvaceae	-	-	I
Sphaeralcea ambigua	SPAM2	Malvaceae	P	FHSu	N
Abronia villosa	ABVI	Nyctaginaceae	A	FH	N
Allionia incarnata	ALIN	Nyctaginaceae	AP	FH	N
Boerhavia coccinea	BOCO	Nyctaginaceae	P	FH	N
Boerhavia erecta	BOER	Nyctaginaceae	AP	FH	N
Boerhavia wrightii	BOWR	Nyctaginaceae	A	FH	N
Mirabilis laevis	MILA6	Nyctaginaceae	P	FHSu	N
Mirabilis multiflora	MIMU	Nyctaginaceae	P	FHSu	N
Selinocarpus nevadensis	SENE5	Nyctaginaceae	P	FHSu	N
Menodora spinescens	MESP2	Oleaceae	P	S	N
Camissonia boothii	CABO7	Onagraceae	A	FH	N
Camissonia brevipes	CABR23	Onagraceae	A	FH	N
Camissonia chamaenerioides	CACH12	Onagraceae	A	FH	N
Camissonia claviformis	CACL4	Onagraceae	A	FH	N
Camissonia refracta	CARE2	Onagraceae	A	FH	N
Camissonia walkeri	CAWA3	Onagraceae	AP	FH	N
Oenothera albicaulis	OEAL	Onagraceae	A	FH	N
Oenothera caespitosa	OECA10	Onagraceae	P	FHSu	N
Oenothera deltoides	OEDE2	Onagraceae	AP	FH	N
Oenothera primiveris	OEPR	Onagraceae	A	FH	N
Oenothera suffrutescens (formerly Gaura coccinea)	OESU3	Onagraceae	P	FHSu	N
Castilleja angustifolia	CAAN7	Orobanchaceae	P	FH	N
Orobanche cooperi	ORCO4	Orobanchaceae	A	FH	N
Argemone munita	ARMU	Papaveraceae	AP	FH	N
Eschscholzia californica	ESCA2	Papaveraceae	AP	FH	N
Eschscholzia glyptosperma	ESGL	Papaveraceae	A	FH	N

Scientific Name	USDA	Family	Duration	Habit	Origin
Eschscholzia minutiflora	ESMI	Papaveraceae	A	FH	N
Plantago ovata	PLOV	Plantaginaceae	A	FH	N
Plantago patagonica	PLPA2	Plantaginaceae	A	FH	N
Achnatherum hymenoides	ACHY	Poaceae	P	G	N
Achnatherum speciosum	ACSP12	Poaceae	P	G	N
Aristida purpurea	ARPU9	Poaceae	AP	G	N
Arundo donax	ARDO4	Poaceae	P	GSSu	I
Avena barbata	AVBA	Poaceae	A	G	I
Bouteloua aristidoides	BOAR	Poaceae	A	G	N
Bouteloua barbata	BOBA2	Poaceae	A	G	N
Bromus arizonicus	BRAR4	Poaceae	A	G	N
Bromus berteroanus	BRBE6	Poaceae	A	G	I
Bromus rubens	BRRU2	Poaceae	A	G	I
Bromus tectorum	BRTE	Poaceae	A	G	I
Dasyochloa pulchella	DAPU7	Poaceae	P	G	N
Elymus elymoides	ELEL5	Poaceae	P	G	N
Heteropogon contortus	HECO10	Poaceae	P	G	N
Hordeum murinum	HOMU	Poaceae	A	G	I
Muhlenbergia porteri	MUPO2	Poaceae	P	G	N
Munroa squarrosa	MUSQ3	Poaceae	A	G	N
Phalaris sp.	PHALA2	Poaceae	-	-	-
Pleuraphis rigida	PLRI3	Poaceae	P	G	N
Poa bigelovii	POBI	Poaceae	A	G	N
Poa secunda	POSE	Poaceae	P	G	N
Polypogon monspeliensis	POMO5	Poaceae	A	G	I
Schismus arabicus	SCAR	Poaceae	A	G	I
Schismus barbatus	SCBA	Poaceae	A	G	I
Sporobolus cryptandrus	SPCR	Poaceae	P	G	N
Tridens muticus	TRMU	Poaceae	P	G	N
Vulpia octoflora	VUOC	Poaceae	A	G	N
Aliciella hutchinsifolia	ALHU6	Polemoniaceae	A	FH	N
Aliciella latifolia (formerly Gilia latifolia)	ALLA13	Polemoniaceae	A	FH	N
Aliciella nyensis	ALNY2	Polemoniaceae	A	FH	N
Eriastrum diffusum	ERDI2	Polemoniaceae	A	FH	N
Eriastrum eremicum	ERER2	Polemoniaceae	A	FH	N
Eriastrum sparsiflorum	ERSP3	Polemoniaceae	A	FH	N
Gilia inconspicua	GIIN2	Polemoniaceae	A	FH	N
Gilia scopulorum	GISC	Polemoniaceae	A	FH	N
Gilia stellata	GIST	Polemoniaceae	A	FH	N
Ipomopsis polycladon	IPPO2	Polemoniaceae	A	FH	N
Langloisia setosissima (spotted flrs.)	LASE3	Polemoniaceae	A	FH	N
Langloisia setosissima ssp. Setosissima (purple	LASES	Polemoniaceae	A	FH	N
Linanthus bigelovii	LIBI2	Polemoniaceae	A	FH	N

Scientific Name	USDA	Family	Duration	Habit	Origin
Linanthus demissus	LIDE2	Polemoniaceae	A	FH	N
Linanthus filiformis (formerly Gilia filiformis)	LIFI3	Polemoniaceae	A	FH	N
Linanthus jonesii	LIJO	Polemoniaceae	A	FH	N
Linanthus pungens	LIPU11	Polemoniaceae	P	FHSu	N
Loeseliastrum matthewsii	LOMA10	Polemoniaceae	A	FH	N
Loeseliastrum schottii	LOSC6	Polemoniaceae	A	FH	N
Chorizanthe brevicornu	CHBR	Polygonaceae	A	FH	N
Chorizanthe corrugata	CHCO6	Polygonaceae	A	FH	N
Chorizanthe rigida	CHRI	Polygonaceae	A	FH	N
Eriogonum deflexum	ERDE6	Polygonaceae	A	FH	N
Eriogonum fasciculatum	ERFA2	Polygonaceae	P	SSu	N
Eriogonum inflatum	ERIN4	Polygonaceae	AP	FH	N
Eriogonum insigne	ERIN10	Polygonaceae	A	FH	N
Eriogonum maculatum	ERMA2	Polygonaceae	A	FH	N
Eriogonum nidularium	ERNI4	Polygonaceae	A	FH	N
Eriogonum pusillum	ERPU6	Polygonaceae	A	FH	N
Eriogonum reniforme	ERRE3	Polygonaceae	A	FH	N
Eriogonum thomasii	ERTH	Polygonaceae	A	FH	N
Eriogonum trichopes	ERTR8	Polygonaceae	A	FH	N
Oxytheca perfoliata	OXPE2	Polygonaceae	A	FH	N
Pterostegia drymarioides	PTDR	Polygonaceae	A	FH	N
Rumex hymenosepalus	RUHY	Polygonaceae	P	FH	N
Cheilanthes parryi	CHPA4	Pteridaceae	P	FH	N
Anemone tuberosa	ANTU	Ranunculaceae	P	FH	N
Delphinium parishii	DEPA	Ranunculaceae	P	FH	N
Oligomeris linifolia	OLLI	Resedaceae	A	FH	N
Coleogyne ramosissima	CORA	Rosaceae	P	S	N
Fallugia paradoxa	FAPA	Rosaceae	P	S	N
Prunus fasciculata	PRFA	Rosaceae	P	S	N
Galium proliferum	GAPR	Rubiaceae	A	FH	N
Galium stellatum	GAST	Rubiaceae	P	FHSu	N
Thamnosma montana	THMO	Rutaceae	P	Su	N
Mimulus bigelovii	MIBI6	Scrophulariaceae	A	FH	N
Mimulus parryi	MIPA4	Scrophulariaceae	A	FH	N
Mimulus rubellus	MIRU	Scrophulariaceae	A	FH	N
Mohavea breviflora	MOBR	Scrophulariaceae	A	FH	N
Neogaerrhinum filipes	NEFI	Scrophulariaceae	A	FH	N
Neogaerrhinum filipes	NEFI	Scrophulariaceae	A	FHV	N
Penstemon bicolor ssp. roseus	PEBIR	Scrophulariaceae	P	FH	N
Datura wrightii	DAWR2	Solanaceae	AP	FHSu	N
Lycium andersonii	LYAN	Solanaceae	P	S	N
Lycium cooperi	LYCO2	Solanaceae	P	S	N
Lycium pallidum	LYPA	Solanaceae	P	S	N
Nicotiana attenuata	NIAT	Solanaceae	A	FH	N

Scientific Name	USDA	Family	Duration	Habit	Origin
Nicotiana obtusifolia	NIOB	Solanaceae	ABP	FHSu	N
Physalis crassifolia	PHCR4	Solanaceae	AP	FHSu	N
Quincula lobata	QULO2	Solanaceae	P	FH	N
Tamarix ramosissima	TARA	Tamaricaceae	P	ST	I
Parietaria hespera	PAHE5	Utricaceae	AP	FH	N
Glandularia gooddingii	GLGO	Verbenaceae	P	FH	N
Phoradendron californicum	PHCA8	Viscaceae	P	SSu	N
Kallstroemia californica	KACA	Zygophyllaceae	A	FH	N
Larrea tridentata	LATR2	Zygophyllaceae	P	S	N

[1] Nomenclature according to USDA-NRCS. 2021. The PLANTS Database (http://plants.usda.gov)

[2] Codes are adopted from the USDA "symbol" comprised of the first two letters of the genus plus the first two letters of the species name. Numbers are used where necessary to distinguish among species with identical four-letter codes. A fifth letter is used to distinguish sub-species or varieties.

[3] The taxonomic family in which the species has been placed.

[4] The typical lifespan: **A**= annual, **B**= biennial or short-lived perennial, **P**= perennial.

[5] The growth habit or form: **G**= graminoid or grass-like, **F**= forb or herbaceous plant with no woody aboveground tissue, **S**= shrub or perennial, multi-stemmed woody plant typically <5m tall, **Su**= subshrub or low-growing shrub typically <0.5m tall, **T**= tree or perennial woody plant with a single stem and typically >5m tall.

6 Native status, **N**= native to Nevada, **I**= introduced to Nevada

Appendix G
Contact Information for Management, Safety, and Services

Contacts

Property Management, Safety, and Services

Agency	Phone Number	Purpose
Desert Conservation Program	702-455-3536	Property and Easement – Management
Boulder City Community Development Department	702-293-9282	Property and Easement – Management
Bureau of Land Management	702-515-5000	Utility Corridors – Management
Boulder City Fire Department	911	Fire – Emergency
		Medical – Emergency
	702-293-9228	Fire Station
Boulder City Police Department	911	Law Enforcement – Emergency
	311	Law Enforcement – Non-emergency
	702-293-9224	Police Station
Nevada Highway Patrol	911	Traffic – Emergency
	702-486-4100	Southern Command
Nevada Department of Transportation	775-888-7689	Highway Tortoise Fences – Maintenance
Bureau of Land Management / National Park Service	702-631-2350	Wildland Fire – Emergency
	702-515-5300	Interagency Communications Center – Non- emergency
	702-293-8932	Law Enforcement – Emergency
	702-293-8998	Law Enforcement – Non-emergency

Appendix F

Riparian Restoration Crediting Methodology

Table of Contents

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Attachment A – Draft Crediting Model

1.0 Introduction

The Desert Conservation Program (DCP) will administer the Multiple Species Habitat Conservation Plan Amendment (MSHCP) on behalf of Clark County (County) and the cities of Las Vegas, Henderson, North Las Vegas, Mesquite, and Boulder City (Permittees). The MSHCP will be crediting preservation of riparian habitat based on a landscape scale model quantifying habitat, and this landscape-scale model will not provide credits beyond preservation. Restoration and enhancement credits for impacts to species and their habitats can typically provide an additional mitigation credit, and the restoration model is structured to provide approximately 1 credit for restoration Projects. In order to account for improvements in site-specific habitat conducted for MSHCP mitigation, WRA, Inc. (WRA) has developed a draft crediting model (Crediting Model). The Crediting Model will allow DCP to measure how habitat improvements rendered by certain actions improve nesting and foraging habitat for three riparian woodland bird species (Target Bird Species): the Bell's vireo (BV: Vireo bellii), southwestern willow flycatcher (SWFL: Empidonax traillii extimus), and western yellow-billed cuckoo (WYBC: Coccyzus americanus occidentalis). The Crediting Model is designed to only apply to the Target Bird Species based on their similar nesting and foraging habitat requirements. Habitats for the Target Bird Species are generally categorized as riparian scrub and woodland in Chapter 5 of the Draft MSHCP. Other riparian species such as Yuma Ridgway's rail have different habitat requirements, and different parameters and values will be needed to measure and credit successful restoration Projects.

In this document, 'Project' refers to the habitat improvement Project being implemented. Improvements are rendered by actions that demonstrably improve nesting and/or foraging habitat for the Target Bird Species. In addition, ecologically important factors (such as location and size) are taken into consideration and scored. Actions and other ecologically important factors that earn scores are known as Creditable Factors.

All Target Bird Species historically nest and forage in the riparian habitats present within the MSHCP boundary and are covered species in the MSHCP. Therefore, the Creditable Factors in the Crediting Model are those actions and elements that aim to improve the size, quality, and contiguity of conserved riparian habitat that can be used as nesting and/or foraging habitat for the Target Bird Species. Restoration and habitat improvement activities benefiting one of these three species have been demonstrated to improve habitat for the other species simultaneously (Lower Colorado River Multi-Species Conservation Program (LCRMSP) 2004).

2.0 How to Use the Crediting Model

Projects that seek to enhance, rehabilitate, or re-establish riparian areas that provide nesting and foraging habitat for Target Bird Species require a way to calculate the improvements rendered through their Project to ascertain how the Project can compensate for impacts to similar habitats approved by the MSHCP. The Crediting Model identifies a suite of Creditable Factors (see Section 3.0) and assigns ecologically relevant scores to each Creditable Factor based on the biology and phenology of the Target Bird Species.

Scores are assigned for each Creditable Factor, ranging from 0 to 1. Scores are determined by the ecological importance of the Creditable Factors relative to adequately replacing the functions lost though permitted impacts. For example, replacing non-native invasive plant species with native riparian species is more important for the Target Bird Species than restricting grazing in existing riparian areas. Therefore, net benefit scores (rendered from removing invasives and planting natives) range up to 1, while restricting

grazing can only earn up to a score of 0.2. Possible scores for each Creditable Factor are described in the following sections. All scores were determined through extensive literature review and collaboration with avian ecologists familiar with the biology and phenology of Target Bird Species.

The credits for a single Project can be calculated by sub area if necessary. This can be necessary when different management actions are implemented on different parts of a single Project. For example, if half of a Project requires significantly more invasive species treatment and planting than the other half of the Project site, each section would earn a unique Net Benefit Score (see Section 3.2). In this case, the entire worksheet should be completed for each Project sub area individually, and the total amount of credits determined by combining the individual results. Sub areas are bound by the physical area within which specific actions are directly applied.

The Crediting Model is intended to be used during Project planning to assist the DCP in calculating the number of credits expected from a proposed Project. It is not expected to be used to calculate credits post Project implementation. The credits are calculated at the time of Project approval and are based on expected outcomes. This will add certainty to the Project credit calculations and ease of management of mitigation tracking. Although the credits do not depend on meeting success criteria, i.e. credits are not held until several years of monitoring are completed, the restoration plans will need to clearly state the Project goals and success criteria and monitoring will need to be conducted to document achievement of the success criteria. This will be needed to document Project success in improving or increasing habitat for the Target Species and provide assurance to the Service that mitigation has been completed.

Attachment A to this memo includes two Tables. Table 1 identifies the Creditable Factors and their possible scores used in the Crediting Model. Project proponents will input the applicable scores from Table 1 into Table 2 to determine the amount of 'credits' their Project earns under the Crediting Model.

3.0 Creditable Factors

The following sections provide a description of the creditable factors that that are taken into account when measuring improvement to nesting and foraging habitat for the Target Bird Species. Similar to the scores introduced above, Creditable Factors were identified based on literature reviews for the species and collaboration with avian ecologists familiar with the biology and phenology of the Target Bird Species. Factors are scored according to their importance in providing nesting habitat for the Target Bird Species. Scores are assigned to each Creditable Factor based on the Project specific details.

The DCP expects to use this Crediting Model to quantify the amount of mitigation credited to each Project that is implemented to offset expected impacts to the Target Bird Species within the MSHCP plan area. As such, the Crediting Model was designed to calculate improvement to ecological factors critical for all three Target Bird Species. While biological and nesting habitat differences exist between the Target Bird Species, the model uses Creditable Factors that improve overall nesting habitat quality and quantity for all three Target Bird Species. When differences exist between the Target Bird Species scores are assigned based on the most stringent need. For example, the minimum nesting patch size for WYBC (approximately 40 acres) is much larger than for the other species. Therefore, points for contiguous riparian habitat are only awarded to Projects implemented that contribute to riparian patches larger than 40 acres.

Creditable Factors include:

- Stream Type: The type of stream (ephemeral, intermittent, or perennial) along which the Project is located.
- Net Benefit: Planting variable height native riparian vegetation and removing invasive non-native species.

- Supplemental Buffer Credit: Whether both sides of a waterway are improved.
- Enacting grazing controls.
- Phasing the removal of invasive plant species.
- Contiguous Riparian Habitat: Project location relative to other protected riparian habitats.

The Creditable Factors were selected based on an in-depth literature review of published research related to the restoration and habitat requirements for each of the Target Bird Species, as well as a detailed evaluation of similar crediting methods from across the Country. Crediting methods reviewed include:

- Credit generation methodologies from conservation banks established for the benefit of riparian bird species across California, Arizona, Nevada, and Texas, including the Southern California Riparian Model used for the Santa Ana River Mitigation Bank (Stein et al. 2000),
- Wetland and riparian conditional and functional assessment methods from California, Nebraska, Kentucky, and Washington, including the following:
    - Riparian Rapid Assessment Method (RipRAM) for California (Central Coast Working Group 2023),
    - Functional Assessment Method for Riparian Ecosystems of Western Placer County, California (Jones & Stokes 2005),
    - Method for Assessing Wetland Functions: Volume I Riverine and Depressional Wetlands in the Lowlands of Western Washington (Hruby et al. 1999),
    - Assessment of Riparian Ecosystem Integrity: Otay River Watershed, San Diego County, California (Smith 2004),
    - Nebraska Stream Condition Assessment Procedure (USACE 2016), and
    - Eastern Kentucky Stream Assessment Protocol (USACE 2002).
- Credit generation methods established by the United States Army Corps of Engineers (USACE) to quantify the amount of stream and riparian credits generated from specific restoration actions, including the Missouri Stream Mitigation Method (USACE 2007) and the Illinois Stream Mitigation Guidance (USACE 2010).

One additional Creditable Factor – temporal lag – was investigated but not included in this Crediting Model. A temporal lag factor can account for the time that habitat restoration or improvement takes to establish and provide the full suite of functions required for the Project to provide suitable nesting and foraging habitat to the Target Bird Species. Providing suitable nesting habitat for WYBC, which requires high canopy (preferably of cottonwood species) is the habitat function that takes the longest time to establish. However, this Crediting Model recommends that the DCP requires cottonwood or other native, high canopy trees be included in restoration planting palettes, and assumes that performance standards will be implemented to ensure the success of the Project. Therefore, providing a score for temporal lag is not deemed necessary at this time.

3.1 Stream Type

Hydrology within the MSHCP Plan area is characterized by a network of alluvial, runoff driven systems, ephemeral washes, and several intermittent and perennial waterways. Dense riparian vegetation capable of supporting all three Target Bird Species is generally restricted to the areas surrounding

perennial and intermittent rivers such as the Muddy River, Virgin River, and Las Vegas Wash. Habitat suitability models (UNR 2020) for each of the three bird species identified these three main intermittent and perennial rivers as containing high potential for suitable habitat for each species.

The WYBC modeled habitat was located almost exclusively along these three systems, as well as along some tributary drainages, isolated areas along the Colorado River, and several isolated patches in southern Clark County. BV and SWFL habitat model results were slightly more expansive, including larger sections along the Colorado River.

As the Crediting Model seeks to quantify improvements rendered that can be utilized by all three Target Bird Species, it is important to prioritize areas which can provide suitable nesting and foraging habitat for all three birds simultaneously. While ephemeral washes can support riparian vegetation, perennial and intermittent streams have sufficient hydrology to support denser, larger, more contiguous riparian habitats while also providing open water foraging opportunities for riparian birds. Breeding habitat for BV includes dense, low, and shrubby riparian vegetation, scrub oak, coast chaparral, mesquite brushlands, and brushy fields near aquatic resources (Wildlife Action Plan Team 2012). The United States Fish and Wildlife Service (USFWS) identifies nesting habitat adjacent to intermittent or perennial watercourses as an Essential Feature for WYBC (USFWS 2021), and BV most frequently nest along perennial or intermittent streams (Averill-Murray and Corman 2005). As such, the Crediting Model assigns a score of 0.3 for Projects located along intermittent and perennial streams, and a score of 0 for Projects located along ephemeral washes to incentivize restoration along intermittent and perennial streams.

3.2 Net Benefit

The Net Benefit Score is determined by the area that is improved via treating invasive plant species and planting native riparian species. Management of invasive plant species, including tamarisk, is a Biological Goal of the MSHCP. Tamarisk is a non-native invasive plant common to Clark County that can displace native vegetation by lowering the water table and creating large salt deposits in soil (Di Tomaso 1998; Periman and Kelly 2000). Tamarisk is more drought tolerant than native riparian species, allowing it to proliferate and outcompete native vegetation during low water years. Although SWFL can nest within tamarisk (USFWS 2013, see Section 3.5), its presence degrades the overall riparian habitat, reduces prey availability/foraging habitat for WYBC, and reduces nesting habitat for WYBC and BV. Therefore, if present on a Project site, removing tamarisk (and other non-native invasive plant species) is a requirement of earning a net benefit score. However, because SWFL utilize tamarisk for nesting, tamarisk removal should be avoided to the greatest extent practicable during the active breeding season between late-May and mid-August (USFWS 2025).

While exhibiting slightly differentiated preferences, all three Target Bird Species generally prefer dense riparian habitats for nesting that are characterized by native riparian species such as willows (Salix spp.) and cottonwoods (Populus spp.). BV prefer dense, low, shrubby riparian vegetation often characterized by newly reset flood prone areas for nesting and they avoid nesting in tamarisk (Tamarix spp.). SWFL, on the other hand, prefer slightly more mature habitats and have been found to nest in tamarisk plants. WYBC prefer to nest higher in the canopy than BV and SWFL in mature cottonwood trees and in areas with less dense shrub sapling layers (Johnson et al. 2008).

The density and extent of native riparian vegetation, especially of cottonwood and willow species, is the largest individual scoring metric of the Crediting Model. Three scores are possible and are based on the percentage of the area which is treated for non-native invasive plant species and planted with native riparian species. If invasive plant species such as tamarisk exist on the Project site, they must

be treated, and native vegetation planted in their place, in order to qualify for the Net Benefit Score. The treatment of non-native species without replacement native planting, or vice versa, can be considered on a case-by-case basis depending on the extent or absence of non-native invasive plants.

Projects earn a score of 1.0 for improving >60% of a riparian area (re-establishing an area), a score of 0.5 for improving between 21% and 59% of an area (rehabilitating an area), and a score of 0.25 for improving up to 20% of an area (enhancing an area). Score thresholds were determined based on the species habitat models completed for the MSHCP, which identified those areas exhibiting >60% riparian cover in the small tree/shrub, medium tree/shrub, and large tree layers as "High" value for all three Target Bird Species (UNR 2020).

3.3 Supplemental Buffer

Protecting both sides of a stream system connects two distinct patches via a natural break of open water foraging habitat for the Target Bird Species such as BV (Barlow 1962; Oberholser 1974). Protecting riparian vegetation on both sides of a stream can also protect the condition of the stream system as a whole by protecting the channel from deleterious land management and uses that could result in degraded stream banks and excessive erosion. Protecting stream banks from excessive erosion can protect the nesting and foraging habitat provided along those banks within riparian habitats. Therefore, the Credit Model provides an additional score if the Project improves both sides of a stretch of stream lying parallel to one another. This Supplemental Buffer Score is calculated by adding the Net Benefit Scores (See Section 3.2) from both sides of the stream and dividing the total value by two. A Project that improves only one side of a stream will not be eligible for the Supplemental Buffer Score.

3.4 Enacting Grazing Controls

Multilayered, generally dense riparian habitat at different levels provides nesting habitat for each of the Target Bird Species. While WYBC also seem to prefer having more open lower layers (shrub/sapling level) as foraging habitat, dense lower layers are critical for BV nesting habitat. When nesting in riparian habitats, BV prefer areas characterized by dense, low vegetation: early successional habitats often developed as the result of a resetting flood event (LCRMSP 2004). Ungulate grazing, including by cattle, can negatively affect the ability of early successional vegetation such as mulefat (Baccharis salicifolia) and willows to rapidly re-establish after a reset event. Outside of post-reset events, overgrazing can also reduce low to medium vegetation density and potentially disturb, damage, or destroy vireo nests, which are often located between 2 and 5 feet above the ground (Audubon Society, 2023).

A score of 0.25 is assigned to Projects which enact grazing restriction measures, such as installing cattle exclusion fencing or implementing cattle deterrent actions. As of the time of this publication, the County has begun pilot projects evaluating the efficacy of various non-fencing methods for cattle deterrence. Further evaluation is required to determine their long-term effectiveness; therefore, any cattle deterrent actions other than the installation of cattle exclusion fencing should be enacted following consultation with the County to earn the associated score. A score of 0 is assigned to Projects which do not enact grazing restriction measures.

3.5 Phasing of Non-native Invasive Removal

Non-native plant species such as tamarisk can displace native riparian vegetation, reduce riparian vertical structure diversity, disrupt hydrologic regimes, and reduce riparian habitat quality by

disrupting thermoregulation. These effects deem it a threat to BV, SWFL, and WYBC. However, SWFL have been known to nest in tamarisk trees (USFWS 2013), and it is considered as suitable nesting habitat by USFWS. Tamarisk can also provide certain habitat functions to the Target Bird Species in those areas lacking native riparian vegetation, such as cover and nesting habitat for SWFL. Therefore, depending on the extent of invasive and native species on a Project site, the immediate and complete removal of tamarisk from the Project site could reduce habitat extent and quality for the Target Bird Species and remove suitable SWFL nesting habitat until those functions and nesting habitat are replaced by maturing native riparian vegetation.

Phasing the removal of non-native invasive plant species such as tamarisk over the course of multiple years could improve Project success. A multi-year study in the Las Vegas Wash found that phasing invasive removal (especially of tamarisk) over the course of several years allowed riparian vegetation community structure to retain habitat characteristics crucial to supporting nesting habitat for the Target Bird Species, including perennial composition, perennial height, vertical structure heterogeneity, and horizontal perennial structure (patchiness) (Braden et al. 2009). Phasing invasive removals – and pairing invasive removal with native plantings – allowed a slower transition from non-native to native dominated riparian habitats and provided a range of habitat types of varying ages that could be used by riparian birds (Braden et al. 2009). Phasing removals allows a Project site to continue providing habitat function and nesting habitat to the Target Bird Species during a transition period, provides an opportunity to re-treat those areas where the original removal wasn't fully successful, and allows planted or naturally recruited native riparian plant species to develop and begin replacing the functions and nesting habitat lost by removing tamarisk. In addition, removing tamarisk during the nesting season for SWFL (Section 3.2) should be avoided to the greatest extent practicable, as SWFL have been identified nesting in tamarisk. To incentivize phasing invasive species removal, the Crediting Model awards a score of 0.5 to Projects that phase invasive removal over three years, a score of 0.35 to Projects that phase invasive removal over two years, and a score of 0 to Projects that do not phase invasive removal.

3.6 Contiguous Riparian Habitat

Larger, contiguous riparian areas insulate nesting and foraging habitat from edge effects such as expansion of non-native invasive plant species, changes in native plant composition and density (Smith & Finch 2013), and reductions in temperature regulation provided by dense riparian habitat (Yonghong et al. 2023). In addition, the WYBC requires relatively large, contiguous patches of riparian habitat to successfully breed. According to the USFWS, optimal patch sizes for WYBC nesting habitat are approximately 200 acres. However, as riparian corridors are often smaller and patchier in the arid southwest (including Clark County), the minimum suitable patch size for WYBC nesting can be as small as 40 acres, as smaller patch sizes can support nesting pair of WYBC and contribute to the recovery of the species (USFWS 2021). SWFL, on the other hand, have been found to nest in patch sizes as small as roughly 1.5 acres (National Park Service 2016).

Individual Projects can contribute to the protection of large riparian habitat blocks by restoring or otherwise improving areas that are contiguous with other protected riparian habitats (increasing the amount of riparian habitat) or enhancing areas that are within large riparian habitat patches. While properties directly contiguous with protected riparian habitats are the ideal, certain situations could exist in which a small distance could separate a Project area from direct connection with a larger protected area. For example, land use easements (such as a telephone pole easement, for example) could legally separate a Project site from a protected area, but this separation might not diminish the benefits rendered from large intact habitats for the Target Bird Species. In this case, while not directly

contiguous, the birds could forage within that easement area and the easement or habitat gap does not effectively separate the two riparian habitat areas into separate habitat patches. Therefore, the entity approving the restoration plan and crediting proposal can evaluate the appropriateness of a Project claiming the contiguous riparian habitat credit on a case-by-case basis.

The Crediting Model seeks to incentivize Projects to be located adjacent to protected blocks of habitat to take advantage of the benefits rendered by larger riparian patches for the Target Bird Species, especially WYBC. Therefore, Projects can earn a score of 0.5 if the area of a Project, when combined with the size of any adjacent, protected, riparian habitat, is greater than 40 acres in size. If a Project is set within an existing protected patch, the size of that patch is included in the calculation for contiguous riparian habitat. That is a Project may be less than 40 acres, but if it occurs within or connects to riparian habitat that is at least 40 acres in size, this additional credit score would be available. Projects which do not meet this 'contiguous riparian habitat' threshold are not awarded any additional score.

4.0 Future Updates

This crediting model has been drafted based on the best available data at the time of publication. As Projects are established for the benefit of the Target Bird Species, the County will gain critical insight into the successes or limitations of specific Projects and actions. Relevant results from future research and advances in science or technology may additionally help to refine this Credit Model and improve Project outcomes. As such, this draft Crediting Model should be reviewed and updated at least every five years to align with review timelines for the Monitoring and Adaptive Management Plan (MAMP) to ensure that the Creditable Factors and their associated values accurately reflect the habitat benefits rendered to the Target Bird Species.

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Attachment A
Draft Crediting Model

Table 1. Creditable Factors and Scores

1. Stream Type	Ephemeral **0**	Intermittent/Perennial **0.3**	
2. Net Benefit (for each side of stream): % of Area planted and/or undesirable vegetation is removed and appropriate native vegetation to be established	<20% **0.1**	21-59% **0.5**	>60% **1.0**
3. Supplemental Buffer Credit	(Net Benefit Score (Stream Side A) + Net Benefit Score (Stream Side B)) 2		
4. Grazing Restrictions Enacted	No **0**	Yes **0.25**	
5. Phased Invasive Removals	All in one year **0**	Over 2 years **0.35**	Over 3 years **0.5**
6. Contiguous Riparian Habitat (minimum 10 ac. project size)	<40 acres **0**	>=40 acres **0.5**	

Table 2. Draft Project Crediting Model

Sub Area #	1	2	3
Sub Area Description			
1. Stream Type			
2. Net Benefit (Stream Side A)			
2. Net Benefit (Stream Side B) (if applicable)			
3. Supplemental Buffer Credit (Buffer on both sides): This is only added if both sides of a stream are protected/improved by the Project			
4. Grazing Restrictions Enacted			
5. Phased Invasive Removal			
6. Contiguous Riparian Habitat			
Sum of scores (M)=			
Acres Improved (S)=			
Credits (C) =M X S			

Total Project acres	0
Total credits generated from all sub areas	0

Appendix G

Riparian Reserves Management Plan (2023)

CLARK COUNTY MULTIPLE SPECIES HABITAT CONSERVATION PLAN

RIPARIAN RESERVES MANAGEMENT PLAN

Version 1.4

April 2023

desert conservation PROGRAM
respect, protect and enjoy our desert!

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Acronyms and Abbreviations

°F	degrees Fahrenheit
AFY	acre-feet per year
BCC	Board of County Commissioners
BCCE	Boulder City Conservation Easement
BGO	Biological Goals and Objectives
BLM	Bureau of Land Management
cfs	cubic feet per second
DCP	Desert Conservation Program
HUC	Hydrologic Unit Code
m	Meters
MSHCP	Multiple Species Habitat Conservation Plan
NDEP	Nevada Division of Environmental Protection
NDOW	Nevada Department of Wildlife
NPS	National Park Service
NRS	Nevada Revised Statutes
Permittees	Clark County, the cities of Boulder City, Henderson, Las Vegas, North Las Vegas, Mesquite, and the Nevada Department of Transportation
RMP	Resource Management Plan
SNPLMA	Southern Nevada Public Lands Management Act
SNWA	Southern Nevada Water Authority
SR	State Route
TNC	The Nature Conservancy
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service

Executive Summary

This management plan identifies the actions to manage the Riparian Reserves as part of the Clark County Reserve System under the Multiple Species Habitat Conservation Plan (MSHCP, Clark County 2000a). This management plan links management actions to the management goals and objectives (as distinct from the biological goals and objectives; Clark County 2016) to restore, conserve, and protect desert riparian habitats for the MSHCP-covered riparian birds, which include southwestern willow flycatcher *(Empidonax traillii extimus)*, yellow-billed cuckoo *(Coccyzus americanus),* Arizona Bell's vireo *(Vireo bellii arizonae),* blue grosbeak *(Passerina caerulea),* summer tanager *(Piranga rubra),* and vermilion flycatcher *(Pyrocephalus rubinus)*. It defines management responsibilities and serves as a guide for the management of the riparian properties acquired by Clark County along the Muddy River and Virgin River to fulfill Condition K of the Incidental Take Permit.

This management plan describes the evolution of the MSHCP, the background of acquiring the riparian properties, and provides detailed descriptions of the reserves including physical, biological, water, and cultural resources; land uses; and ecological stressors to the natural resources. The primary section of this plan is the identification of management goals, objectives, and actions. As listed in the table below, the goals are broad, general statements that establish the management direction of the reserves, whereas the management objectives provide further explanation regarding the intent of the goals. Numerous actions are planned that define day-to-day management activities and identify additional actions, steps, and tools to meet these management objectives and to achieve goals. Each management action is linked to measures that assess the effectiveness of the action, the success of this management plan.

Goal/ Objective	Management Goals and Objectives for the Riparian Reserves
Goal 1	**Manage reserves to provide habitat for the six MSHCP covered avian species**
Objectives	*1.0 Restore, create, and enhance habitat for riparian bird species*
Goal 2	**Manage reserves to support resource values for other MSHCP and sensitive species when practicable**
Objectives	*2.0 Manage habitat to avoid harm to aquatic species*
Goal 3	**Manage reserves to meet conservation and landowner obligations**
Objectives	*3.0 Control invasive plant species and noxious weeds*
	4.0 Reduce threat of fire and maintain safe conditions
	5.0 Manage property rights and property infrastructure
	6.0 Build and maintain positive relationships in the community
Goal 4	**Expand property holdings of desert riparian habitats for MSHCP covered species**
Objectives	*7.0 Acquire title to private lands from willing sellers*
	8.0 Acquire conservation easements to public and private lands with willing landowners as appropriate

Summary of Updates

Version	Summary of Updates
1.1 (2017)	• Added discussion on ecological resilience and its relationship to ecological stressors (Section 2.6.3) • Incorporation of the 2016 Biological Goals and Objectives (BGOs) in the Appendix E table (Management and effectiveness measures)
1.2 (2019)	• Restructured document to better accommodate sites added since the last document revision and streamline addition of future sites • Addition of specific management actions and descriptions of each site
1.3 (2021)	• Updated property information to reflect additional properties purchased since the 2019 version. • Restructured document to reduce redundancy and overall streamline the text. • Added clarifying language to differentiate between the management goals and objectives in this management plan versus the Biological Goals and Objectives (Section 3) • Added a discussion on the 3 R's of ecological resiliency (Section 1.7) • Appendix E (Management and effectiveness measures table) incorporated into Section 3.3 • Moved select information from the body of the document to appendices to improve overall readability (list of plants [Appendix C] and birds [Appendix D] observed in the Riparian Reserves). • Added a new Section, Section 4- "Considerations for Future Versions of the Riparian Management Plan" intended to keep track of suggestions from members of the Science Advisor Panel that were not implemented in the current version for various reasons, but that should be considered before conducting the next management plan update.
1.4 (2023)	• Editorial and minor updates throughout • Updated maps, references

Section 1 Introduction

The Clark County Desert Conservation Program (DCP) manages Endangered Species Act compliance on behalf of Clark County and the cities of Boulder City, Henderson, Las Vegas, North Las Vegas, Mesquite, and the Nevada Department of Transportation (collectively, the Permittees) through implementation of the Clark County Multiple Species Habitat Conservation Plan (MSHCP) and associated Section 10(a)(1)(B) incidental take permit. Condition K of the incidental take permit stipulates that take of covered avian species is conditioned upon the acquisition of private lands in desert riparian habitats along the Muddy and Virgin rivers and the Meadow Valley Wash (U.S. Fish and Wildlife Service [USFWS] 2001). To comply with this permit condition, the DCP has acquired properties with riparian habitat along the Virgin and Muddy Rivers in Clark County, Nevada (Figure 1; Appendix A). These properties comprise the Muddy River Reserve and the Virgin River Reserve (collectively, the Riparian Reserves), part of the overall Clark County Reserve System portfolio, which serves to mitigate impacts to covered species and conserve habitats and important wildlife connectivity corridors. To date, Meadow Valley Wash properties have not been included in the Riparian Reserves because willing sellers of suitable habitat within the Meadow Valley Wash system have not been identified.

The purpose of this management plan is to identify actions by which to manage the Riparian Reserves in a manner that restores, conserves, and protects desert riparian habitats for avian species covered by the MSHCP, as listed in Table 1. Additional information on habitat requirements and monitoring for these species are included in Appendix C and Table C-1 of the *Adaptive Management and Monitoring Plan* (AMMP; Alta 2023). Species listed in Table 1 are the focus of management goals and objectives for the Riparian Reserves; however, it is expected that management for the protection of these species will provide benefits for many other species, including additional MSHCP-covered species.

Table 1. Riparian Avian Species Covered by the MSHCP

Common Name	Scientific Name	Status
Southwestern willow flycatcher	*Empidonax traillii extimus*	FE, SE
Yellow-billed cuckoo	*Coccyzus americanus*	FT, SS
Blue grosbeak	*Passerina caerulea*	-
Summer tanager	*Piranga rubra*	-
Vermillion flycatcher	*Pyrocephalus rubinus*	-
Arizona Bell's vireo	*Vireo bellii arizonae*	-
FE – federally listed endangered FT – federally listed threatened SE – state listed endangered SS – state listed sensitive		

This plan links management actions to the management goals and objectives for the reserves (Section 3.2) and establishes overall direction and clarifies management responsibilities (Section 1.4). It serves as a guide for nondiscretionary activities and defines future discretionary actions to achieve desired riparian habitat conditions. Implementation of some management actions will continue to be detailed in separate and specific restoration or management plans. This management plan and the management goals, objectives, and actions will be reviewed and revised as appropriate every two years by the DCP. Updates to this management plan may also occur whenever new information that influences management is available (adaptive management) and when additional properties are acquired for desert riparian habitat conservation. This current plan is Version 1.3 and incorporates revisions and updates from Version 1.0 (Clark County 2015), Version 1.1 (Clark County 2017b), and Version 1.2 (Clark County 2019a). Revisions and updates will ensure this management plan is current with

changes to internal and surrounding land use, changes in ecological conditions (floods, fire), changes as a result of management activities (closed roads, restoration of habitat), and changes based on new information from on-site research studies and other published sources. See Clark County (2017a) for the adaptive management and monitoring plan for MSHCP-covered riparian species and their habitats.

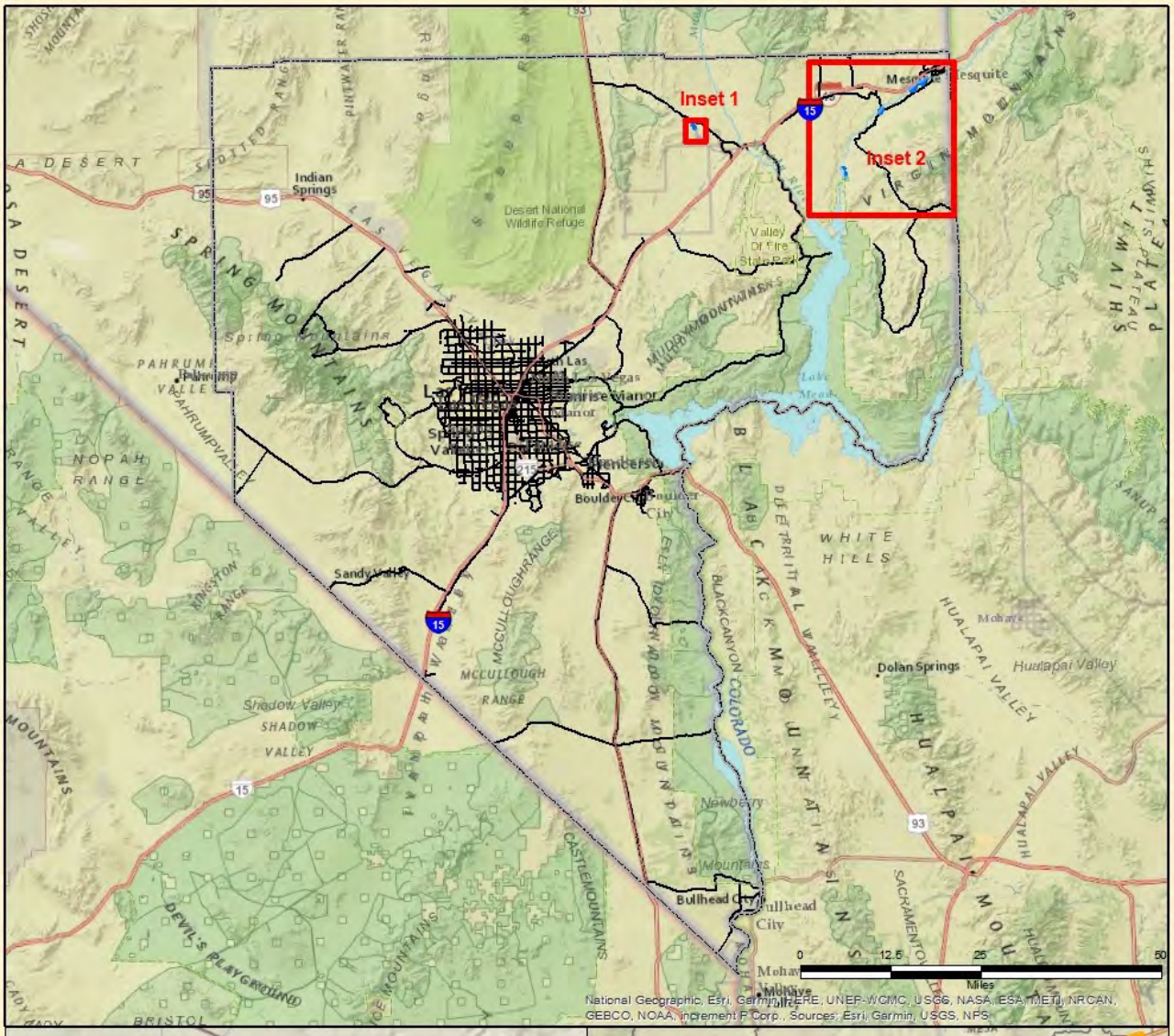
Several terms are used here to describe management areas. Parcels are the smallest spatial units, with discrete property boundaries, locations, and acreages. Adjacent parcels are often aggregated into a 'site' and may be generally referred to as a collective 'property' for management actions (e. g., Riverside or Bunkerville East). On the Virgin River, sites are also identified by river reaches within Clark County (numbered 1-5, upstream to downstream, based on Hydrologic Unit Codes designated within the National Hydrography Dataset). There are no reaches yet identified on the Muddy River. The Virgin River, the Muddy River, and Meadow Valley Wash are designated as individual reserves within the Riparian Reserve of the DCP. The organization of sites and parcels has evolved over the lifetime of the Reserve System and will continue to do so with new additions.

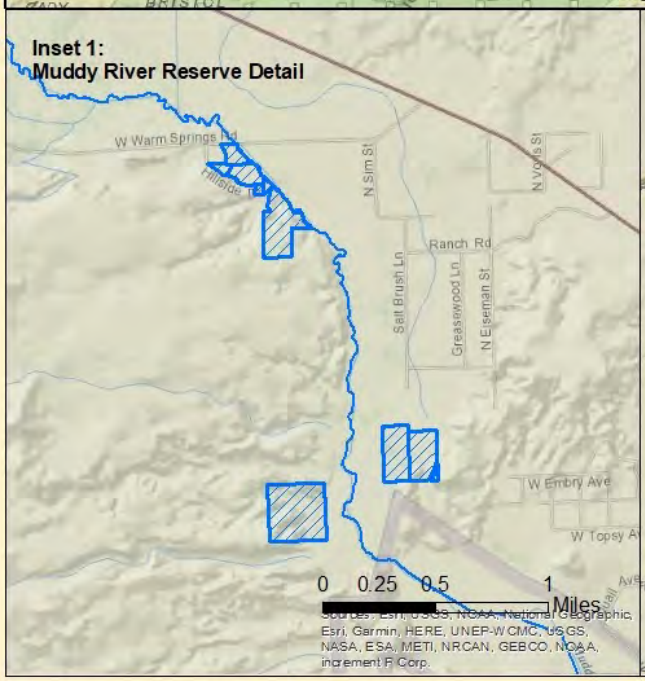
1.1 History and Expansion of the Riparian Reserves

The desert riparian watersheds of the Muddy River, Virgin River, and Meadow Valley Wash are identified as unique habitats and resources addressed by the MSHCP. The Biological and Conference Opinion (USFWS 2000) for the MSHCP was issued on the basis that private land within these riparian watersheds would be acquired for conservation of the MSHCP-covered bird species listed in Table 1. Expansion of the Riparian Reserves is through voluntary sales only and is directed by guidance described below. The current total acreage in the Riparian Reserves is 782 acres.

The initial phase of the MSHCP's implementation included the Muddy River Land Acquisition Program (USFWS 2000). The Nature Conservancy (TNC) assisted Clark County in implementing this program by working with willing sellers to explore the use of a variety of real estate options to implement conservation actions on priority parcels. TNC, on Clark County's behalf, acquired nine parcels of land, including water and development rights, from three willing sellers from 2002 through 2004 using funds from the Southern Nevada Public Lands Management Act (SNPLMA) account for purchasing of environmentally sensitive lands. The nine parcels of land total 116.5 acres (Figure 1). TNC managed these properties until they were transferred to Clark County in 2010 and 2011. Individual parcel sizes and dates of acquisition are provided in Table 4 (Section 2.1), below.

Clark County has also acquired property in the lower Virgin River watershed totaling 665 acres (Figure 1). These parcels are grouped into five sites: Bunkerville East, Bunkerville West, Mesquite (sometimes referred to as Mesquite West), Mormon Mesa, Mormon Mesa South, and Riverside. The Mormon Mesa property was the first on the Virgin River to be acquired by Clark County when it was transferred from Clark County Parks and Recreation Department to the DCP in 2011. Since then, 17 additional parcels have been acquired as property from willing private sellers becomes available. Individual parcel sizes and dates of acquisition is provided in Table 5 (Section 2.2), below.





Riparian Reserves

Riparian Reserves Overview

Figure 1

Projection: Transverse Mercator
Coordinate System: UTM Zone 11
Datum: NAD83
Date: 05/01/2023
Name: Riparian_Management_Overview Fig 1

1.1.2 Expansion Criteria

The DCP, either directly through Clark County or in cooperation with a third negotiating party, will continue to acquire interests in real property and water rights in the riparian areas on a willing-seller/willing-buyer basis. Interest in real property could include fee title (legal ownership by County) or a conservation easement (legal agreement between landowner and County for permanent restrictions on land use for conservation values).

The DCP developed an acquisition selection tool to rank and prioritize properties based on the environmental and administrative criteria listed in Table 2. A series of questions were generated for each criterion to further define, describe, and explain the criterion. A value of 1 is assigned if the question can be answered affirmatively or the response is desirable and 0 if answered negatively or undesirable. The only exception to these values is for the species evaluation criterion, which is assigned a value of 2 if affirmative or desirable. The total possible value each for environmental criteria and administrative criteria is divided into thirds to set three ranges by where to assign priority. The list of questions and criteria are applied to each prospective property to arrive at a total value and then assigned a priority of 1, 2, or 3 based on what value range the property falls within. The list of criteria questions and example value matrix are included in Appendix B. The DCP will use the selection tool for acquisition of riparian properties from willing sellers along the Muddy River, Virgin River, and Meadow Valley Wash as specified in the incidental take permit but may consider opportunities to acquire riparian property throughout Clark County.

Table 2. Acquisition Selection Criteria

Administrative Criteria
Ease of management Complexity of land acquisition process Potential for degradation of habitat if not purchased for conservation
Environmental Criteria
Species evaluation Proximity to sensitive lands Restoration Potential

The BLM Cadastral Survey Office was funded to complete a metes and bounds survey under an agreement with the DCP to define the federal property boundaries in the unincorporated towns of Riverside and Bunkerville along the Virgin River, and to create official final survey plats. The final survey plats will be used to locate and identify encroachments on federal land by adjacent private landowners. Any encroachments will need to be resolved to ensure clear title of private property before DCP can pursue acquisition from willing sellers.

1.2 Guiding Documents

The primary guiding documents for the MSHCP include:

- MSHCP and Environmental Impact Statement (Clark County 2000a)
- Incidental Take Permit No. TE034927-0 (USFWS 2001)
- MSHCP Implementing Agreement (Clark County 2000b)
- Biological and Conference Opinion (USFWS 2000)

These documents are available electronically at:

https://www.clarkcountynv.gov/government/departments/environment_and_sustainability/desert_conservation_program/guiding_documents.php

The Section 10(a)(1)(B) incidental take permit is the primary guiding document that specifies the acquisition and management of riparian properties. Condition J.2 of the incidental take permit requires the "development and/or revision of conservation management plans that identify the management and monitoring actions" for riparian habitats of the Muddy River, Virgin River, and Meadow Valley Wash. In fulfillment of Condition J.2, the DCP has prepared and/or participated in the development of the Virgin River Conservation Management Assessment (Entrix Inc. 2008), Final Upper Muddy River Watershed Assessment (Provencher et al. 2005), and the Meadow Valley Wash Final Baseline Ecological Assessment (BIO-WEST Inc. 2005).

The "acquisition of private lands in desert riparian habitats" along these waterways for covered MSHCP avian species is mandated under Condition K.1 of the incidental take permit. Further, the MSHCP and the Biological and Conference Opinion describe measures to minimize and mitigate impacts of take, while the MSHCP and the Implementing Agreement specify the responsible parties to undertake these measures. These measures include acquisition by Clark County of conservation easements or other interests in real property by purchase, exchange, or donation to meet management goals and objectives necessary or appropriate for riparian birds.

1.2.1 Muddy River Guiding Documents

Several planning documents have been developed for the Muddy River Reserve on behalf of the DCP. These include the Upper Muddy River Site Conservation Plan (TNC 1999; 2000), the Draft Preliminary Management Plan for Upper Muddy River Aquatic and Floodplain Habitats in Clark County, Nevada (Wainscott 2004), and the Integrated Science Assessment for the Upper Muddy River, Clark County, Nevada (Provencher et al. 2005). Preliminary restoration and conservation actions on the Muddy River Reserve conducted by TNC and funded by the DCP on behalf of the MSHCP were based primarily on these documents.

1.2.2 Virgin River Guiding Documents

The DCP has funded several planning documents to guide management actions within the Virgin River Reserve. In 2008, the Virgin River Conservation Management Assessment (Entrix Inc. 2008) was developed in conjunction with land management agencies to identify the management and monitoring actions needed for the desert riparian habitat within the Virgin River watershed. In 2013, two reports were produced for Reach 5 located in the Lower Mormon Mesa area: the Mormon Mesa Ecohydrology Assessment Final Report (Orr et al. 2013b) was produced to recommend locations and strategies for restoration for the area, and the Clark County Mormon Mesa Parcel Restoration Plan (Orr et al. 2013a) was developed to provide property-specific restoration planning recommendations. An Ecohydrology Assessment, including flood-scour analysis, vegetation mapping, and restoration suitability for the entire Virgin River was completed in 2014 (Stillwater Sciences 2014) and a more focused Ecohydrology Assessment was prepared for the Gold Butte - Mesquite Reach of the Virgin River (including the Bunkerville site) (Stillwater Sciences 2017). These reports help identify restoration potential for acquisition.

1.3 Applicable Regulations

Certain federal, state, and local regulations apply to the actions that occur on the Riparian Reserves. Any restoration or conservation action that could adversely affect the flood capacity of the 100-year floodplain is subject to review and approval by the Clark County Department of Public Works to meet the requirements of the National Flood Insurance Program. Fill material

(e.g., soil, rip-rap) placed below the ordinary high water mark of the rivers or in adjacent wetlands is subject to review and permit by the U.S. Army Corps of Engineers and by the Nevada Division of Environmental Protection (NDEP) under Sections 404 and 401, respectively, of the Clean Water Act. If construction equipment or any discharge must enter the waterway to implement a restoration or conservation action, review and approval of working in the waterway is required by NDEP under Section 402 of the Clean Water Act. Any restoration project that disturbs more than one acre is subject to the provisions of stormwater discharge controls under Section 402 of the Clean Water Act and requires compliance with the Construction Stormwater General Permit issued by NDEP. Land clearing using machinery is subject to dust control permitting under Section 94 of the Clark County air quality regulations. Restoration that could involve actions on Bureau of Land Management (BLM) land would be subject to the Federal Land Policy and Management Act for applicable right-of-way authorization. Involvement of the U.S. Army Corps of Engineers or BLM triggers environmental and cultural assessments under the National Environmental Policy Act and National Historic Preservation Act.

Water rights conveyed with the properties are managed in accordance with chapters 533 and 534 of the Nevada Revised Statutes (NRS). Lastly, any restoration, conservation, or other management action that could disturb or otherwise cause take of nesting songbirds or raptors is prohibited by the Migratory Bird Treaty Act and will likely require consultation with the USFWS.

1.4 Management Roles and Responsibilities

Clark County serves as the implementing agent on behalf of the Permittees, and the DCP is the Plan Administrator for the MSHCP. The MSHCP and Implementing Agreement set forth the responsible parties for required management activities for the conservation of covered species. The DCP, as administrator of the MSHCP, has the primary management role for the Clark County Riparian Reserves.

The Clark County Board of County Commissioners (BCC) review and approve the budget and expenditure of funds by DCP to manage the reserves, as well as review the DCP's selection of contractors, approve contract awards, and obligate funds for conservation projects.

The DCP acts on behalf of the BCC as the landowner and serves in the primary role of implementing the day-to-day activities to manage the reserves in accordance with Clark County codes and ordinances and the guiding documents of the MSHCP. The DCP is responsible for planning and implementing nondiscretionary management actions for the long-term maintenance of the reserves for the benefit of species covered by the MSHCP. The DCP is responsible for reviewing this management plan for any changes or additions to management goals, objectives, and actions for the reserves, and to update the priority and implementation status of management actions.

1.5 Implementation Plan and Budget Process

The MSHCP provides guidance on developing biennial budgets for implementation. The DCP, as the MSHCP Administrator, is responsible for developing a biennial Implementation Plan and Budget that is responsive to key provisions outlined in the MSHCP. Although the process of developing the Implementation Plan and Budget has varied over the past biennia, the general steps of the budget development process are to determine available funding and to identify and recommend actions that further the purpose of the MSHCP. Certain actions that are stipulated by the Section 10 incidental take permit are considered required expenditures to maintain compliance, and therefore are nondiscretionary. These nondiscretionary actions include administering and managing the MSHCP implementation, supporting the Adaptive Management

Program, managing the Boulder City Conservation Easement, managing acquired properties and water rights, maintaining the tortoise fencing program along major roads, wild tortoise pick-up services, and the public information and education program. Other actions that further the goals and objectives of the MSHCP but are not directly specified in the incidental take permit are considered discretionary, such as scientific research projects and desert tortoise augmentation projects. The administration and management of the Riparian Reserves necessary to protect and maintain the existing resource values are nondiscretionary actions. This Riparian Reserves Management Plan serves as the guiding document for planning and implementation of nondiscretionary activities for managing acquired properties and water rights, as well as discretionary actions that further the goals and objectives of the MSHCP but are not directly stated in the incidental take permit. Both nondiscretionary and discretionary actions are funded through the biennial Implementation Plan and Budget process and are approved by the BCC.

Management actions on the Clark County Riparian Reserves are primarily funded through Section 10 mitigation fees and from grants funded by the proceeds from federal land sales under SNPLMA. Other outside sources of funding for conservation actions could include private grants, donations of in-kind services and labor, and mitigation fees paid by third parties as part of their compliance with Section 7 of the Endangered Species Act, or Section 404 of the Clean Water Act. These third-party Section 7 mitigation fees are typically restricted to enhancement or restoration of habitat for listed or sensitive species, and Section 404 mitigation fees are restricted to established in-lieu fee agreements or mitigation banks.

1.6 Historical and Biological Resources Setting

1.6.1 Cultural History and Resources

The history of the area has been extensively documented. The archaeological sequence and record of the Moapa Valley and Virgin River Valley indicate continuous occupation of the areas from 300 B.C. to historic times. The earliest recorded occupation of the southern Nevada region was by the Virgin Anasazi peoples whose culture is characterized by a horticultural subsistence base, permanent architectural features, ceramic production, and tools such as hoes, digging sticks, and grinding implements suitable for processing large quantities of grain. Remains of this culture have been recorded on the high bluffs overlooking the confluence of the Muddy and Virgin rivers. Early settlers of the valley recorded the presence of numerous irrigation ditches leading from the Muddy River to fields in the floodplain, indicating that they had an extensive irrigation system. With the decline of the Virgin Anasazi came Numic-speaking peoples, especially the Southern Paiute and Patayan (Ezzo 1996).

The earliest Europeans were Spanish explorers who traveled through the area in the 1770s. The first travelers over what is now known as the Old Spanish Trail were probably fur trappers. The Mormon Wagon Road originating in Salt Lake City and traversing southern Nevada along the Muddy and Virgin rivers helped to establish the region as a Mormon stronghold (Ezzo 1996).

European settlement began in the mid-1860s and the Moapa Indian Reservation was created in 1873. The town of Bunkerville was founded on religious (Mormon) principles in 1877. After several years, this area was initially abandoned due to challenges associated with trying to “tame” the Virgin River and quicksand, but around 1895, Mormons returned to the area and began to farm. West Point was the first recorded Mormon settlement in the upper Muddy River valley in 1968. The settlement began with the construction of a fort, irrigation ditch, and a willow corral. The present day remains of the West Point settlement include several mounds of adobe melt, partially intact cobble foundations, tent dugouts, and a portion of an irrigation ditch (Ezzo 1996).

In 2015, a Cultural Resources Class I Review was conducted for the Muddy River Reserve (KLA. 2015) and a Cultural Resources Site Assessment for the Virgin River Reserve was conducted in 2020 (SWCA 2020a).

1.6.2 Flora and Fauna Resources

Desert riparian habitat used to be prevalent on the Colorado River and its tributaries (Virgin, Muddy, and Pahranagat) (Wildlife Action Plan Team 2012). The primary native vegetation species in this ecosystem are Fremont cottonwood (*Populus fremontii*), velvet ash (*Fraxinus velutina*), and Goodding's willow (*Salix gooddingii*). These deciduous tree species are important as nesting habitat for bird species and provide shade and mitigate water temperatures for native stream and river species. This habitat has been significantly reduced in extent (by development, agriculture, fire, and the lowering of the local and regional aquifers) and quality (non-native invasive plant species, including tamarisk [Tamarisk spp.]). The loss of the desert riparian habitat has impacted many bird and fish species.

Native plants observed during surveys conducted in 2012 in the Muddy River Reserve and in 2013 in the Virgin River Reserve are included in Appendix C.

Avian species observed during bird surveys in the Muddy River Reserve (2008, 2009, and 2017-present) and Virgin River Reserve (2017-present) are included in Appendix D.

Federally endangered species that occur in the Muddy River or Virgin River include the Moapa dace (*Moapa coriacea*), woundfin (*Plagopterus argentissimus*), and Virgin River chub (*Gila seminude*). Fish surveys are conducted annually by the Nevada Department of Wildlife (NDOW) but are not covered species under the MSHCP and are therefore not discussed in detail in this document. Surveys for other species, including bats, small mammal, and pollinators have also been conducted.

Noxious and Invasive Weeds

Noxious weeds are those weeds designated as a pest by state or federal law or regulation. The state of Nevada designates plants as noxious if the plant is found to be "detrimental or destructive and difficult to control or eradicate" (NRS 555.005). Invasive weeds are non-native species whose introduction does or is likely to cause economic or environmental harm (The National Invasive Species Council 2006).

Surveys for noxious and invasive weeds are conducted throughout the year on the Riparian Reserves. Further surveys and treatment of noxious weeds will continue to occur on a semi-annual basis. Noxious and invasive species are treated using an integrated weed management approach. Treatment methods may include, but are not limited to, herbicide application, cut-stump with herbicide application, or hand-pulling, with the particular treatment method depending on the species being treated and the time of year that the treatment is applied. A list of noxious and invasive species that have been documented during surveys is provided in Table 3 below.

Table 3. Noxious and Invasive Weeds

Common Name	Scientific Name	State Listed Noxious[1]
Muddy River Reserve		
Russian knapweed	*Acroptilon repens*	B
Australian saltbush	*Atriplex semibaccata*	No
Fivehook bassia	*Bassia hyssopifolia*	No
Red brome	*Bromus rubens*	No
Malta starthistle	*Centaurea melitensis*	A
Field bindweed	*Convolvulus arvensis*	No
Horseweed, marestail	*Conyza canadensis*	No
Bermuda grass	*Cynodon dactylon*	No
Redstem stork's bill	*Erodium cicutarium*	No
Prickly lettuce	*Lactuca serriola*	No
African mustard	*Malcolmia Africana*	No
Russian thistle	*Salsola kali*	No
London rocket	*Sisymbrium irio*	No
Saltcedar	*Tamarix ramosissima*	C
Puncturevine	*Tribulus terrestris*	C
Virgin River Reserve		
Camelthorn	*Alhagi maurorum*	A
Bermuda grass	*Cynodon dactylon*	No
Tall whitetop	*Lepidium latifolium*	C
Saltcedar	*Tamarix ramosissima*	C

[1] Nevada Department of Agriculture noxious weed categories:

- Category A weeds are generally not found or are limited in distribution throughout the state. These species are subject to active exclusion from the state, eradication where found, and eradication from nursery stock.
- Category B weeds are generally established in scattered populations in some counties of the state. These species are subject to active exclusion where possible and active eradication from nursery stock.
- Category C weeds are generally established and widespread in many counties of the state. These species are subject to active eradication from nursery stock.

Source: Nevada Department of Agriculture (https://agri.nv.gov/Plant/Noxious_Weeds/Noxious_Weed_List/; accessed 16 Feb 2021)

1.6.3 Climate

Climate in the Moapa Valley and lower Virgin River watershed is typical of the Mojave Desert with low humidity and high evaporation rates. Summers are hot and dry with temperatures in excess of 100 degrees Fahrenheit (°F) and winters are short and generally mild. Average daily temperatures during the summer are over 90 ºF, with average winter daily temperature around 46 ºF. Spring and autumn are generally moderate with average daily temperatures of 80 ºF (Provencher et al. 2005, Entrix Inc. 2008).

Precipitation is generally from longer-duration, low-intensity winter events associated with frontal systems or from shorter-duration, high-intensity summer storms. In general, the valley floors receive 3 to 5 inches of precipitation per year while the highest mountain elevations receive an average annual precipitation of 12 inches or more. Maximum precipitation normally falls between November and March, while minimum precipitation occurs in May, June, September, and October. Thunderstorms are common during July and August, contributing between 25 and 30 percent of annual precipitation. Little precipitation infiltrates to groundwater and storm events

of intense precipitation result in sheet flow across the desert floor and flash flooding in washes that are normally dry (Provencher et al. 2005, Entrix Inc. 2008).

Future climate conditions are discussed in Section 1.8.

1.7 Ecological Resilience

Ecological resiliency (as defined in Clark County 2016) is the capacity of an ecosystem to withstand acute and diffuse stressors without experiencing widespread negative regime changes, such as species extirpation or a fundamental loss of ecosystem function. To better understand how ecological resiliency can be practically addressed on the Riparian Reserves, putting it in the context of ecological conservation is important. Ecological representation, redundancy, and resiliency make up "The Three R's of Conservation" and are described here:

- Representation— describes the ecosystems or vertebrate species present on a landscape within designated management units or study areas (e.g., riparian parcel, site, or reach). Key concepts regarding representation include:
    - o Saving something of everything.
    - o Conserving a full variety of habitat types or species.
    - o If representation exists within designated management units or study areas, there is a higher potential for protecting biodiversity under climate change.
- Redundancy— describes the redundancy (i.e., number of occurrences) an ecosystem, habitat type, or vertebrate species is on a particular landscape within designated management units or study areas. Key concepts regarding redundancy include:
    - o Redundancy can be a hedge against the failure of any particular species population or habitat type.
- Resiliency— describes the capacity of an ecosystem, habitat type, or vertebrate species to respond to perturbation by resisting, recovering, and/or transforming. It is important to identify the target:
    - o What is the focal system, habitat type, or vertebrate species?
    - o Resiliency…of what? [key components of the system, habitat type, or vertebrate species].
    - o Resiliency…to what? [specific disturbance, disruption, and uncertainty].

Representation, redundancy, and resiliency, and their applicability to specific project and management concepts were discussed at an internal workshop in 2018 (Alta 2018). Each of the Three R's were discussed in relation to both fine-scale and landscape levels and a multitude of project concepts were evaluated (project concepts were both new concepts and those already being implemented). Overall, the following management concepts work to achieve or inform representation, redundancy, and resiliency:

- Maintain spatial connectivity and spatiotemporal variability in ecological processes
- Understanding natural levels of spatial and temporal variability
- Strategic property acquisition and partnerships; and

Identification of key ecosystem stressors and the types of ecological changes that may be affected by these stressors (i.e., filling in the blanks of “Resiliency...of what?” and “Resiliency…to what?”).

1.8 Ecological Stressors for MSHCP-Covered Species and Habitats

Ecological resilience within the Riparian Reserves can be increased through such actions as maintaining and enhancing habitat connectivity at site and landscape scales, as well as identifying and addressing uncertainties related to management actions and broader planning goals and objectives. Managing for ecological resilience benefits from an understanding of natural levels of spatial and temporal variability, identification of key ecosystem stressors, and the types of ecological changes that may be affected by these stressors.

The primary stressors (or threats) affecting desert riparian habitats in southern Nevada are summarized from several documents, including the MSHCP (Clark County 2000a), site conservation plans developed by TNC (TNC 1999; 2000), and the Virgin River Conservation Management Assessment (Entrix Inc. 2008). The first two threats described are considered the priority threats on which to focus management actions in Section 3.

Non-native and Invasive Species

Non-native and invasive plant species can alter the structure and composition of desert riparian habitat, alter the stream hydrology and soil moisture, and alter the fire regime. Non-native plant species can severely affect riparian habitat over a wide range in both rivers, increasing the challenges of restoring these habitats. Many noxious weeds have been identified on both the Virgin and Muddy River reserves (Table 3) as well as documented in the watersheds. The DCP currently conducts weed surveys and treatments on the Muddy River and Virgin River Reserves.

Tamarisk (or saltcedar) is the primary invasive plant species in riparian habitat in the Mojave Desert, and is designated as a Category C noxious weed by the Nevada Department of Agriculture. The species has spread rapidly along riparian corridors, displacing native species and forming dense monocultures. Tamarisk can increase wildfire severity, adds salinity to the soil, and provides limited habitat for native species, although several riparian birds can and do use it for nesting.

Another non-native species that ecologically impacts riparian habitat is fan palm (*Washingtonia californica*). Fan palm displaces native species, reduces refugia, and establishes a new fire regime that is more frequent and intense.

The non-native tamarisk leaf beetle (*Diorhabda elongata*) was introduced by the U.S. Department of Agriculture (USDA) in the southwest U.S. as a biological control agent for tamarisk. The beetles feed on the leaves of tamarisk and defoliate the plant, which compromises the plant’s ability to photosynthesize and store food resources in its roots. Prior to the arrival of the beetles, southwestern willow flycatchers had successfully nested in tamarisk-dominated habitats. Flycatchers rely on dense riparian tree and shrub communities for breeding. However, the rapid defoliation of tamarisk caused by the tamarisk leaf beetle has resulted in reproductive failure of southwestern willow flycatchers in areas that are recently defoliated. This rapid defoliation of tamarisk has affected numerous other species that also rely on the dense vegetation of desert riparian ecosystems. Widespread defoliation due to tamarisk leaf beetles was documented on the Virgin River Reserve, Mesquite site, 2010 and on the Muddy River Reserve and the Virgin River Reserve, Mormon Mesa site, in 2012 (Tom Dudley, personal communication).

Altered Local and Regional Aquifers and Altered Surface Flow

The flow of the Muddy River has been reduced by almost one-third over the last 2 to 3 decades, primarily due to groundwater removal for power generation but also for municipal water, agricultural irrigation, and domestic water supplies (TNC 2000). It is the perennial nature of the river with a relatively constant flow of water throughout the year that makes the Muddy River one of the most unique riparian systems in the Mojave Desert ecoregion. Residential growth in the Moapa Valley has historically been 2 to 3 percent annually (TNC 2000), but there have been proposals for larger-scale developments, not only in the valley but also in areas that would affect the groundwater flow to the Muddy River, such as the Coyote Springs development. The BLM Rapid Ecological Assessment for the Mojave Desert Ecoregion projects that surface water and groundwater use will increase by over 25 percent in the Moapa Valley in the next 50 years (Comer et al. 2013).

The Lower Virgin River has a relatively natural flow regime as it is not dammed, but some water is diverted for municipal and industrial use, stockwater and recreation use, and irrigation purposes (Winters and Johnson 2004).

Altered local and regional aquifers reduce the amount of water available for riparian and aquatic species in both rivers and result in changes to the flood regime, further altering native vegetation structure.

Fire

Wildfires are becoming more common in the Mojave Desert ecosystem (Van Linn et al. 2013). Mojave Desert species did not evolve with fire; thus, fire has a detrimental ecological effect in the ecosystem. Fire is fueled primarily by invasive annual grasses and introduced plants in the uplands that provide fine and large fuels. Fires from the uplands can spread into riparian habitat. Fire scars within the Virgin River Reserve and Mormon Mesa suggest that fire has played a role in the dominance of tamarisk. Fire alters the composition and structure of the riparian habitat, reducing structure for woody species that survive fire and eliminating some woody species. The increase of non-native grasses establishes a reoccurring cycle of fire that further degrades habitat. Fire threat can be very severe and restoration after a fire is difficult. Fire is a threat in both river systems.

Livestock Trespass

Trespass by livestock occurs on all parcels of the Virgin River Reserve. Livestock modifies habitat (e.g., soil surface topography, permeability of soil) and trample and graze on native plants.

Livestock trampling and grazing is a high risk for revegetation efforts. Current practices to reduce this threat include installing barriers to prevent entry by trespass livestock. These measures are costly to install and maintain.

Development

Natural conditions, including water supplies within the northeast planning area of Clark County, present constraints to new development. Large portions of the area are mountainous, have steep slopes, or are in regulated floodplains. The requirements of the MSHCP may also further restrict development. Large contiguous areas for residential developments are limited because of the extent of federal land ownership in Clark County. Development would likely occur on in-fill parcels based on planned land uses and existing zoning. Areas designated for disposal by the BLM for development are not in riparian habitats. The threats to riparian habitats from development would be low.

Infrastructure

Transportation and transmission corridors are low threats to the riparian systems on both rivers. Siting of transmission lines and utility corridors are predominately governed by the BLM through the Resource Management Plan (RMP) process because of the extent of federal land ownership within Clark County. Transportation and transmission corridors cause habitat alteration and fragmentation, and avian species are at risk from collisions with transmission lines. Existing infrastructure is low in severity and low in areal extent near the Riparian Reserves. There is water conveyance infrastructure i.e., an irrigation canal that runs through the Riverside parcels.

Agriculture

Agriculture (row crops, fruit and landscape trees, and pasture) is not extensive near the Muddy River Reserve but does cover large areas along the lower Muddy River and south of the Virgin River Reserve around the community of Bunkerville. The threats from agriculture include livestock trespass, altered hydrologic regime from water withdrawal, habitat loss and fragmentation, and toxins and organic enrichment to the river system from runoff. Revegetation from past agricultural clearing is an option in some reaches of both rivers.

Climate Change

Projections of climate change for the northeast Mojave Desert suggest that the changes will be profound by 2060 (Comer et al. 2013), including substantial changes in most monthly maximum temperatures, July maximum temperature, and August minimum temperature. Some of the potential effects of climate change include decrease in plant growth, expansion of invasive species distribution and density, increase in fire frequency, increase in wind erosion, higher evapotranspiration rates, earlier drawdown of stream levels and ground water, shrinkage of areas of perennial flow, reduction of riparian vegetation, reduction of groundwater recharge, and increase in flood events from higher precipitation levels at high elevations (Comer et al. 2013). Climate change can be a severe threat to these ecological systems and species over the next 50 years.

Specific predictions quoted below are intended to provide context to current climatic condition (Section 1.6.3) and are taken from Kalansky et al. 2018:

> "…..warming could range between 3-5˚F by 2030-2050 and 5-10˚F by 2100 in southern Nevada……The largest seasonal temperature changes in the future occur in the fall, closely followed by the summer and particularly for nighttime temperatures."
>
> "By mid-century, Clark County will likely experience approximately 40 – 50 more days above 100˚F compared to today…..Temperatures rapidly rise through the end of the century under RCP8.5, where extreme heat days (>115-120˚F) are projected to increase to over 50 days per year." See Figure E-5 in Kalansky et al. 2018 (https://www.wucaonline.org/assets/pdf/pubs-clark-county-climate-report.pdf) for a graphical illustration comparing modeled future maximum temperatures to current observations.
>
> "Projected changes in precipitation are small and highly uncertain, in part due to the large natural interannual and decadal variability of precipitation in the region, but also because rainfall is difficult to model given GCM resolution. Projections indicate increasing precipitation variability and more frequent extreme precipitation events in the future. Seasonally, spring may be drier by the end of the century, although the

number of wet days will increase which means fewer large springtime precipitation events."

1.9 Land Use

1.9.1 Land Use Planning

Land use and land management practices can have a significant impact on natural resources, including water, soil, nutrients, plants, and animals. Land use of parcels held in private, by the Southern Nevada Water Authority (SNWA), or under Clark County ownership is governed by the Northeast Clark County Land Use Plan (Clark County 2019b), Warm Springs Natural Area Stewardship Plan (SNWA 2011), and Clark County Regional Flood Control master plans for Bunkerville (2017), Mesquite (2017), and the Muddy River (Moapa Valley 2016). Management and future use of the BLM lands are governed by the Las Vegas Resource Management Plan (BLM 1998). Other plans that govern uses on adjacent and nearby federal and state lands include the Lower Colorado River Multi-Species Habitat Conservation Plan (Lower Colorado River Multi-Species Conservation Program 2004), Desert National Wildlife Refuge Complex Comprehensive Conservation Plan (USFWS 2009), and Overton Wildlife Management Area Conceptual Management Plan (NDOW 2014). The riparian properties along the Muddy and Virgin rivers are within the geographic boundaries of the Northeast Clark County Land Use Plan (Clark County 2019b). Existing and planned land uses do not always coincide with current zoning classifications.

1.9.2 Land Use Permit Requests

The Riparian Reserves are available for use for scientific surveys and data collection. The DCP developed a procedure by which third parties request permission to participate in allowable conservation-based activities on the Riparian Reserves. In general, activities that disturb the soil, remove vegetation or seeds, or require handling or removal of animals (including insects or spiders) require written permission from the DCP. Any interested third party will follow the permit request process included in Appendix E and submit a permission form to the DCP before accessing the reserves to start work. Contractors for DCP projects are not required to complete the permission form.

1.10 Public Services and Safety

Public services and safety address the agencies responsible for utilities and emergency response to the areas that encompass the Riparian Reserves and the safety procedures followed by the DCP and contractors that access the reserves. Since the Riparian Reserves are located in the unincorporated areas of Clark County, public safety services are provided by County agencies.

Agency contacts and telephone numbers are listed in Appendix F.

1.10.1 Fire and Medical

The Clark County Fire Department provides fire protection and emergency medical response for the northeast area of the County. The Riparian Reserves are served by volunteer firefighters from Station 71 in Bunkerville and Station 72 in Moapa. The BLM rangers are responsible for fire and medical emergency response on BLM land.

1.10.2 Law Enforcement

The Las Vegas Metropolitan Police Department is the agency providing police protection in the northeast area of the County. The Department has a resident officer program serving the communities of Bunkerville, Moapa, Glendale, Overton, and Logandale. The Nevada Highway Patrol enforces traffic regulations on the highways and state routes. The BLM rangers patrol federal lands and are responsible for protecting the resources, illegal dumping, and traffic code enforcement on BLM land.

1.10.3 Utilities

Muddy River Reserve, Parcel B is serviced by municipal water provided by the Moapa Valley Water District and by electrical service provided by Overton Power District. Sewer service for the house that was removed from Parcel B was a septic system. There are no utilities that service Virgin River Reserve.

1.10.4 Safety

The DCP follows standard health and safety procedures for working in desert environments, including guidelines for weather-related risks and biological hazards (snakes, insects).

In the past, illegal marijuana grow operations have been documented in the Muddy River area. Caution should always be taken when visiting the reserves while being cognizant of unknown irrigation lines or dumping areas. The BLM Office of Law Enforcement and Security should be notified of any suspect sign of illegal behavior in the area by reporting it to 702-515-5178.

Emergency contact is provided through the 911 service; non-emergency support is requested by dialing 311. Cell phone service is available on and near the reserves through most telecommunication carriers.

Section 2 Riparian Reserve Descriptions

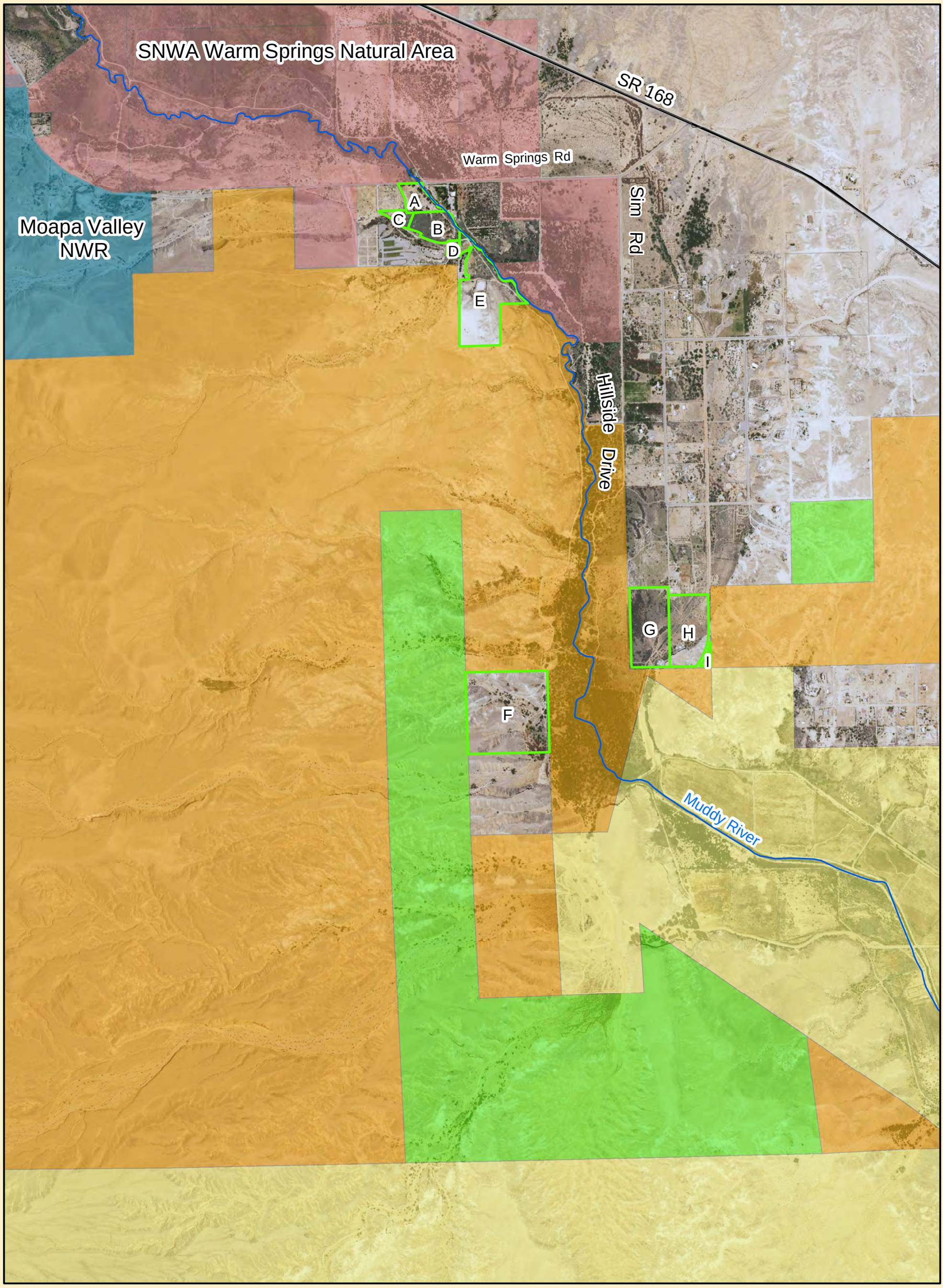
The Riparian Reserves consist of the Muddy River Reserve and the Virgin River Reserve and are further described below. As previously noted, no properties along the Meadow Valley Wash have been acquired by Clark County, and therefore, this watershed is not described in this section.

2.1 Muddy River Reserve

The Muddy River Reserve is located in the northeastern Mojave Desert ecosystem within Moapa Valley and consists of 116.48 acres in nine parcels. For the sake of convenience, the parcels have been labeled sequentially from A to I (Figure 2). The locations of the properties shown in Figure 2 are listed by Clark County Assessor's parcel number in Muddy River Parcels.

Table 4. Muddy River Parcels

Parcel Code	Parcel #	Acres	Year Acquired
A	030-22-501-004	6.37	2002
B	030-22-501-022	6.30	2002
C	030-22-501-021	2.07	2010
D	030-22-501-010	1.14	2010
E	030-23-201-003	25.06	2010
F	030-26-301-001	40.00	2010
G	030-26-601-001	18.65	2010
H	030-26-601-002	16.52	2010
I	030-26-601-003	0.37	2010
	Total Acreage	**116.48**	



Legend

- Riparian_Reserves

SNDO_land_status

NAME

- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Reclamation
- Fish and Wildlife Service
- Nevada State
- Private

Muddy River Reserve Land Ownership

Figure 2

0 0.25 0.5 1

Miles

Coordinate System: UTM Zone 11
Datum: NAD83
Date: 7/01/2021
Name: Riparian_Management_muddy_fig2

N W E S

2.1.1 Existing and Adjacent Land Use

Parcels within the Muddy River Reserve are zoned as rural open land (1 residential unit per 2 acres) with the planned land use shown in the Northeast Clark County Land Use Plan as public facilities, except for Parcel F, which is designated as open land. The public facilities category allows large areas of permanent open land and easements. One purpose of the open land use category is to prevent irreversible environmental damage to sensitive areas (Clark County 2019b). The existing use of the reserve is for the conservation of riparian habitat. Allowable uses include scientific surveys and data collection with the permission of the DCP.

Land ownership and use adjacent to the reserve in the upper Muddy River floodplain and surrounding upland is a combination of federal multiple use, refuge, and reservation (BLM, USFWS, and tribal lands), conservation use (SNWA land), and residential, agricultural, and commercial uses (private land) (Figure 2).

Notable adjacent land uses are described in the bullets below.

- The **Warm Springs Natural Area**, located north and east of the Muddy River Reserve (especially near parcels A, B, and E), is managed by SNWA to protect the federally endangered Moapa dace, restore natural habitat, protect water resources, and provide recreational and educational opportunities for the public (SNWA 2011). The area consists of 1,220 acres of floodplain and surrounding uplands, with 3.8 miles of Muddy River riverfront. Development of nature trails and interpretive zones at the Warm Springs Natural Area were completed in 2018 to include more opportunities for public use to increase awareness about the challenges of water management and the biodiversity of the area.
- **USFWS** manages the headwaters of the Muddy River as the Moapa Valley National Wildlife Refuge. The refuge was established in 1979 for the conservation of the Moapa dace and other species that depend on the thermal spring habitat of the headwaters. The refuge covers 116 acres and is managed as part of the Desert National Wildlife Refuge Complex. This refuge is not directly adjacent to the Muddy River Parcels, but is considered a notable land use.
- The **Moapa River Indian Reservation** encompasses the floodplain south of Parcel H along approximately 2.4 river miles.
- **NV Energy** manages the property to the west and north of Parcels A and C. This area was used to pump and deliver groundwater for the operation of the Reid Gardner Power Plant (since closed and demolished) located approximately 5.5 river miles downstream.
- **Private property** on the east bank of parcels A, B, and E are used for agriculture (tree farm) as well as a rural residence with commercial recreation/RV park. The planned land use designation for these properties is commercial neighborhood. This designation allows low to medium intensity commercial services, including an existing recreational vehicle park.
- **Private property** owned by the Moapa band of Paiutes adjacent to the south of Parcels B and C has a history of being used as a nursery for landscape plants.

The remaining adjacent land uses include BLM land managed for multiple uses, and private property that are used for rural residences or are open land.

2.1.2 Future Land Use

Any revisions or updates to the BLM Las Vegas Resource Management Plan (BLM 1998) could change which nearby parcels would be available for disposal and future private development, and which areas would have further restrictions on use under an Area of Critical Environmental Concern designation.

2.1.3 Geology and Soils

The soils in the upper Muddy River watershed have been mapped (Natural Resources Conservation Service 2015), albeit coarsely and lacking relevant detail for this management plan. The soils along the river are Anthony fine sandy loams, a floodplain soil that is moderately well drained with no or slight salinity. Downcutting by the river has isolated this floodplain soil from the current river flows, especially downstream from the Warm Springs Bridge to I-15 (TNC 2000). Several areas along the river have extensive fill along the river channel. The floodplain further from the river is Gila soil type; loam to sandy loam soils that are moderately well drained with no to slight salinity (Natural Resources Conservation Service 2015). These two soil types make up the 100-year floodplain of the upper Muddy River which has a spatial extent of approximately 7,700 acres (TNC 2000). The uplands are mostly badlands, with exposed rock and colluvium.

2.1.4 Topography

The topography of the area around the Muddy River Reserve consists of an entrenched river, a narrow to moderately wide floodplain along the river, and steeper slopes up to the surrounding flat mesas. The upper Muddy River cuts through dating back to 5.3 million years ago alluvial fans, dating back to 5.3 million years ago, and lacustrine sediments that form the surrounding uplands (TNC 2000). The Arrow Canyon Range and a series of small ridges of Quaternary alluvium are along the upper reaches of the river. Elevation ranges from 1,520 to 1,800 feet.

2.1.5 MSHCP-Covered Plant Species

Plant inventory surveys within the Muddy River Reserve were conducted by the National Park Service Exotic Plant Management Team in winter of 2012. No covered or evaluation MSHCP species were observed during the survey; however, one watch list species, barrel cactus (*Ferocactus cylindraceus*) was observed. A complete list of native plant species observed in the Muddy River reserve unit is included in Appendix C.

2.1.6 MSHCP-Covered Avian Species

Avian surveys were conducted within the reserve in 2008 and 2009 and have occurred annually since 2017 (SWCA 2017a, SWCA 2017b, SWCA 2019, SWCA 2020, SWCA 2021, SWCA 2022). The following MSHCP-covered species were observed during these surveys: Yellow-billed cuckoo, American peregrine falcon (*Falco peregrinus*), Arizona Bell's vireo, blue grosbeak, phainopepla, and summer tanager (the American peregrine falcon and phainopepla are not typically riparian species and as such are not included in Table 1). A southwestern willow flycatcher was detected during point count surveys in one year of surveys, but it was prior to June 25, indicating it could have been a migrant from the more northerly subspecies and not the federally protected southwestern subspecies (SWCA 2017a). Additionally, one evaluation species, the crissal thrasher (*Toxostoma crissale*) was also documented within the Muddy River Reserve.

2.1.7 Water Resources

Surface Water and Groundwater

The Muddy River is a perennial, spring-fed river that originates from a series of thermal springs approximately 60 miles northeast of Las Vegas in the unincorporated towns of Moapa and Glendale (Wainscott 2004) (Figure 3). The discharge from the thermal springs ranges from 86 to 89 °F and contributes 30 to 40 percent of the total river flow. Groundwater discharge contributes 60 to 70 percent of the total river flow. The groundwater flows come from the channel of the historical White River, which flowed from central Nevada to the Colorado River. The White River is now discontinuous along its length and is below ground from Pahranagat to the source of groundwater discharge into the Muddy River (TNC 2000).

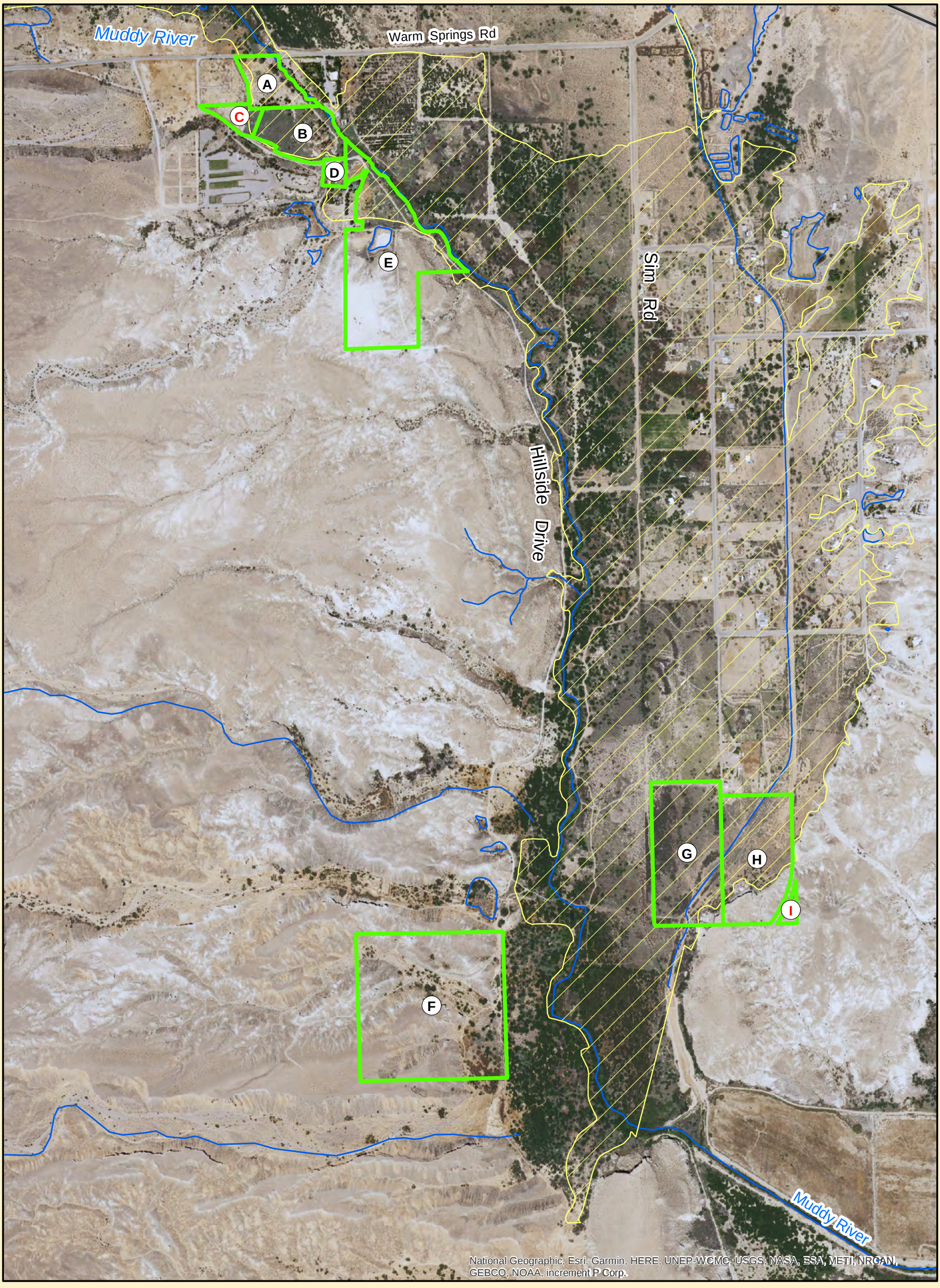
The Muddy River flows some 26 miles from its source into the impounded Colorado River. The Lake Mead impoundment submerges the last 7 river miles of the Muddy River. Prior to the impoundment of the Colorado River, the Muddy River joined with the Virgin River for a short distance before emptying into the Colorado River. The river has a relatively constant flow with an average annual discharge of 25,000 acre-feet per year (AFY) (TNC 2000). This has been reduced from 36,000 AFY over the past 2 to 3 decades, primarily due to groundwater removal for power generation but also for municipal water, agricultural irrigation, and domestic water supplies (TNC 2000). The perennial nature of the river with a relatively constant flow of water throughout the year is unique within the Mojave Desert ecoregion.

All or parts of Parcels A, B, C, D, E, G, and H are within the 100-year floodplain of the Muddy River (Figure 3). Parcels F and I are outside the floodplain.

Water Rights

All surface water and groundwater within the boundaries of Nevada belong to the public and are subject to appropriation for beneficial uses such as irrigation, recreation, wildlife, and stock watering, and for domestic, municipal, and industrial uses. The use of a water right is considered a property right and can be bought and sold like any other property. Water rights are purchased or sold as personal property or treated as an appurtenance in a real estate transaction. Holders of water rights must demonstrate an actual beneficial use of water in a timely manner. If holders stop using the water, the water right is lost.

Water rights were conveyed to Clark County with the purchase of Muddy River parcels C through F. There is also a municipal water connection on parcel C with the Moapa Valley Water District. The acquired rights were for groundwater for irrigation and domestic uses. The DCP filed a Report of Conveyance with the State Engineer to establish Clark County as the owner of record of the water permits.



Legend

- Muddy_River_Reserve

FEMA Flood Zone

FZONE

- ZONE A
- ZONE AE
- ZONE AO
- FEMA Rivers and Washes

Muddy River Reserve Water Resources

Figure 3

0 0.125 0.25 0.5

Miles

Coordinate System: UTM Zone 11
Datum: NAD83
Date: 7/1/2021
Name: Riparian_Management_muddy_fig3

2.1.8 Site Narratives and Restoration Priorities

The following descriptions for Muddy River properties are based on staff observation, field notes, and reports from contractors performing surveys on each parcel. Information varies for each site and parcel due to factors such as: length of time the property has been owned by Clark County, access to property, number of ongoing and/or past projects, etc. The following narratives are intended to describe conditions at each site and provide general rationale for the types of restoration activities that may occur at each site.

Restoration priorities are based on specific site conditions, as well as the stressors described in Section 1.8. For example, all parcels include 'tamarisk treatments' as a restoration priority because tamarisk is an invasive species described in Section 1.8 that is widespread throughout the riparian reserve properties and has known negative ecological impacts.

Parcels A-E:

The Muddy River channel within these parcels is incised into a now-dry floodplain. Dominant species include quailbush (*Atriplex lentiformis*) and arrowweed (*Pluchea sericea*), with scattered domestic landscape species (i.e., palm, mulberry, and pine) from previous land uses. Some scattered willow and ash occur along the river.

Restoration priorities include reconnecting the Muddy River with its floodplain and creating habitat for bird species listed in the MSHCP.

Parcel F:

Parcel F is semi-desert grassland that lies outside the 100-year floodplain. Dominant vegetation includes tamarisk (*Tamarix sp.*), honey mesquite (*Prosopis glandulos*a), and quailbush (*Atriplex lentiformis*). Grassland areas are dominated by alkali sacaton (*Sporobolus airoides*). In March 2018, approximately 20% of the tamarisk (on this parcel) was cut and stump treated. In late 2020, the remainder of the tamarisk on this parcel was cut and stump treated.

Restoration priorities include a continuation of the ongoing tamarisk treatments, select weed treatments (ongoing by NPS), and revegetation after tamarisk treatments.

Parcels G and H:

Parcels G and H are semi-desert grassland with dominant cover species including tamarisk (*Tamarix sp.*), honey mesquite (*Prosopis glandulos*a), and quailbush (*Atriplex lentiformis*). Grassland areas are dominated by alkali sacaton.

These properties are split by a series of Clark County flood control channels. Four distinct channels of various cross sections enter the north-central portion of Parcel H, some of which are contained by tall berms. These channels appear to drain a significant catchment area, based on analysis of USGS topography maps, of approximately 8.6 square miles as they enter the site. Approximately 500 feet south of the northern boundary, all the containment berms end and channels become less defined and braided. This series of braided channels gather at the south-central boundary of parcel G as the valley is pinched by the large bluff to the east and exits the unit as a single gully. This confluence zone is characterized by significant erosion, with raw, steep channel banks and numerous headcuts.

Restoration priorities are general in nature and include tamarisk treatments, select weed treatments (ongoing by NPS), and revegetation after tamarisk treatments.

Parcel I:

Parcel I is located on the bluff outside the 100-year floodplain and is dominated by upland vegetation species. Its restoration priorities are general in nature and are identical to those for

parcels G and H, including tamarisk treatments, select weed treatments (ongoing by NPS), and revegetation after tamarisk treatments.

2.2 Virgin River Reserve

As of March 2021, Clark County has acquired title to 545.5 acres distributed across sixteen parcels in five locations in the lower Virgin River watershed. The locations are identified according to the Hydrologic Unit Code (HUC) reach location (Figure 1) and include Mesquite (sometimes referred to as Mesquite West) (Reach 1), Bunkerville East (Reach 2), Bunkerville West (Reach 2), Riverside (Reach 3), and Mormon Mesa (Reach 5). Due to their close proximity, Bunkerville East, Bunkerville West, and Mesquite parcels are often displayed on the same map and lumped together as 'Bunkerville'. Parcels are labelled using their Reach ID followed by a letter (e.g., all parcels in HUC Reach 2 have labels beginning"2-") (Table 5).

Table 5. Virgin River Parcels

Site Name	Reach Id*	Parcel #	Acres	Year Acquired
Mesquite West	1-A	001-19-201-009	11.19	2018
Bunkerville East	2-A	002-24-401-004	17.36	2017
	2-B	002-24-401-002	21.46	2017
	2-C	002-24-401-001	2.62	2014
	2-D	002-24-401-005	37.06	2014
	2-E	002-24-801-005	9.98	2014
	2-F	002-25-501-013	56.97	2014
	2-G	002-24-801-002	8.09	2014
Bunkerville West	2-I	002-27-801-002	40	2018
	2-J	002-26-401-001	61.73	2018
	2-K	002-26-301-002	0.76	2020
	2-L	002-26-301-004	15.59	2020
	2-M	002-26-301-007	42.59	2020
Riverside	3-A	034-00-001-013	39.85	2018
	3-B	034-00-001-019	100	2017
Mormon Mesa	5-A	039-19-000-002	80.22	1990
Mormon Mesa South	6-A	039-30-201-013	40	2021
Mormon Mesa South	6-B	039-30-301-009	80	2021

Total Acreage 545.47

*River reaches are designated based on the National Hydrography Dataset, Hydrologic Unit Codes and are numbered from upstream to downstream for purposes here.

2.2.1 Existing and Adjacent Land Use

Parcels within the Virgin River Reserve are zoned as rural open land (1 residential unit per 2 acres) with the planned land use designated as open land or rural residential. One purpose of the designated open land use category is to prevent irreversible environmental damage to sensitive areas (Clark County 2019b). The designated rural residential use category allows for a large lot, single family residential (1 unit per 2 acres) (Clark County 2019b). The existing use of all the parcels on the reserve is for the conservation of riparian habitat. Allowable uses include scientific surveys and data collection with the permission of the DCP.

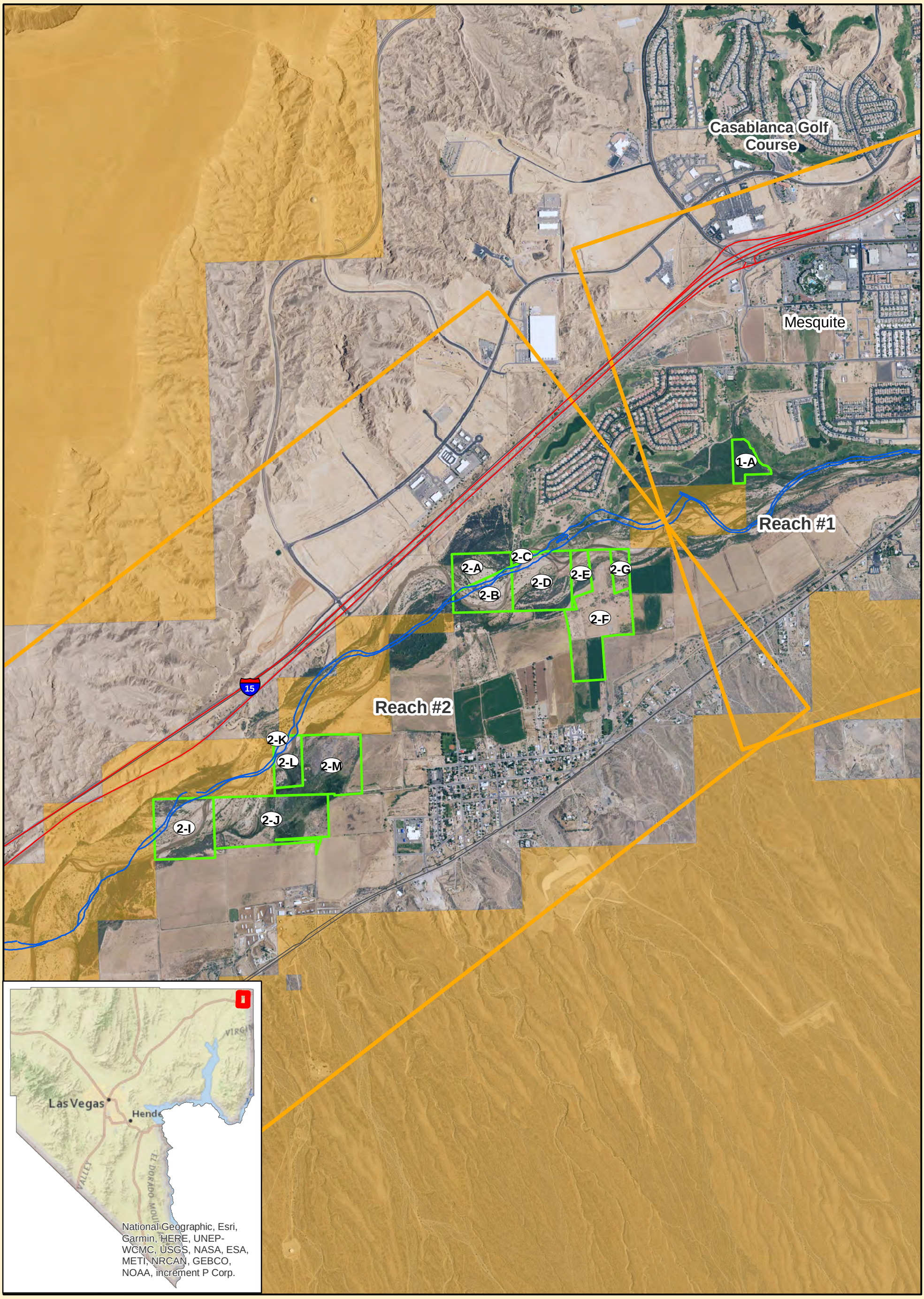
Adjacent land use descriptions are briefly described in the bullets below:

- The Mesquite parcel (Figure 4) is bordered to the south by land managed by the BLM and a golf course located in a private residential neighborhood. Zoning is for a Planned Unit Development (PUD, Clark County 2019b).
- Bunkerville East parcels (Figure 4) are bordered to the north by land managed by the BLM and a golf course located in a private residential neighborhood. Land bordering these parcels is zoned residential agricultural and the current use is agriculture. Surrounding private property is used for agriculture and open land.
- Bunkerville West parcels (Figure 4) are bordered by private owners and is zoned rural residential agriculture.
- The Riverside parcels (Figure 5) are bordered by both BLM land managed as multiple use land and private properties. Zoning is Rural Open Land (Clark County 2019b).
- The Mormon Mesa parcel (Figure 6) is bordered to the east and north by NDOW-managed land as part of the Overton Wildlife Management Area, which is managed for the protection of wildlife habitat. Property to the west and south is managed as multiple use land by the BLM.

Much of the river channel and adjacent floodplain along the lower Virgin River corridor south of the City of Mesquite is managed by the BLM, National Park Service, and NDOW, with some smaller parcels under the management of the Bureau of Reclamation. Parcels in private ownership are scattered along the length of the lower Virgin River. Existing uses of these parcels are open lands and agriculture, with zoning designations primarily as rural open land (1 residential unit per 2 acres) further south along the river, and residential agriculture (1 residential unit per 1 acre) in and near the communities of Bunkerville and Mesquite.

2.2.2 Future Land Use

Future uses of private properties adjacent to reserve parcels are likely limited for two reasons: 1) floodplain management restrictions, and 2) the entire length of the Virgin River in Clark County is designated critical habitat for the southwestern willow flycatcher (USFWS 2013) and the yellow-billed cuckoo (USFWS 2014).



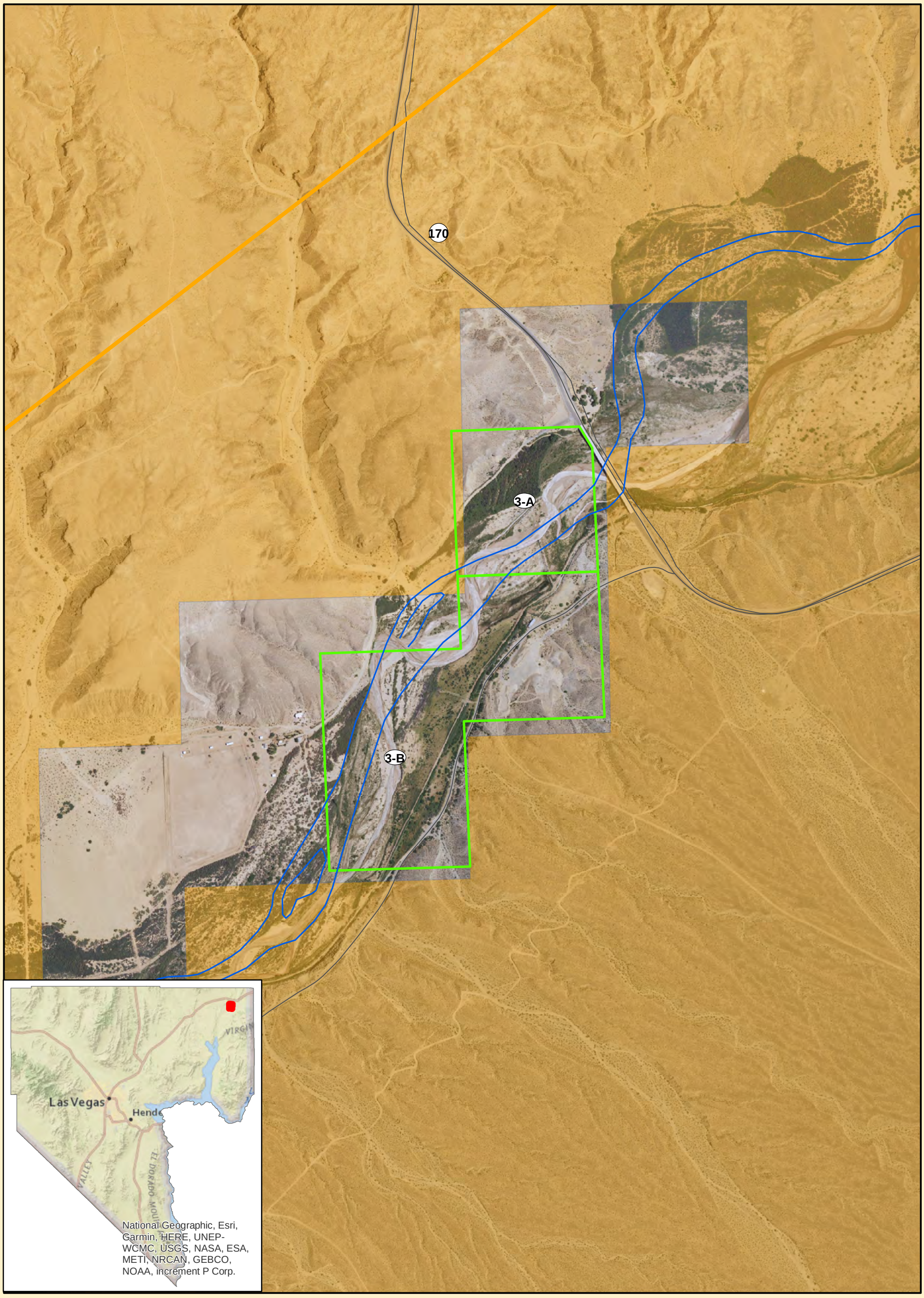
Bureau of Land Management
Private
Reserve Reach

Virgin River Reserve Mesquite and Bunkerville Land Ownership Figure 4

0 0.25 0.5 1
Miles

Coordinate System: UTM Zone 11
Datum: NAD83
Date: 7/1/2021
Name: Riparian_Management_virgin

N
W E
S

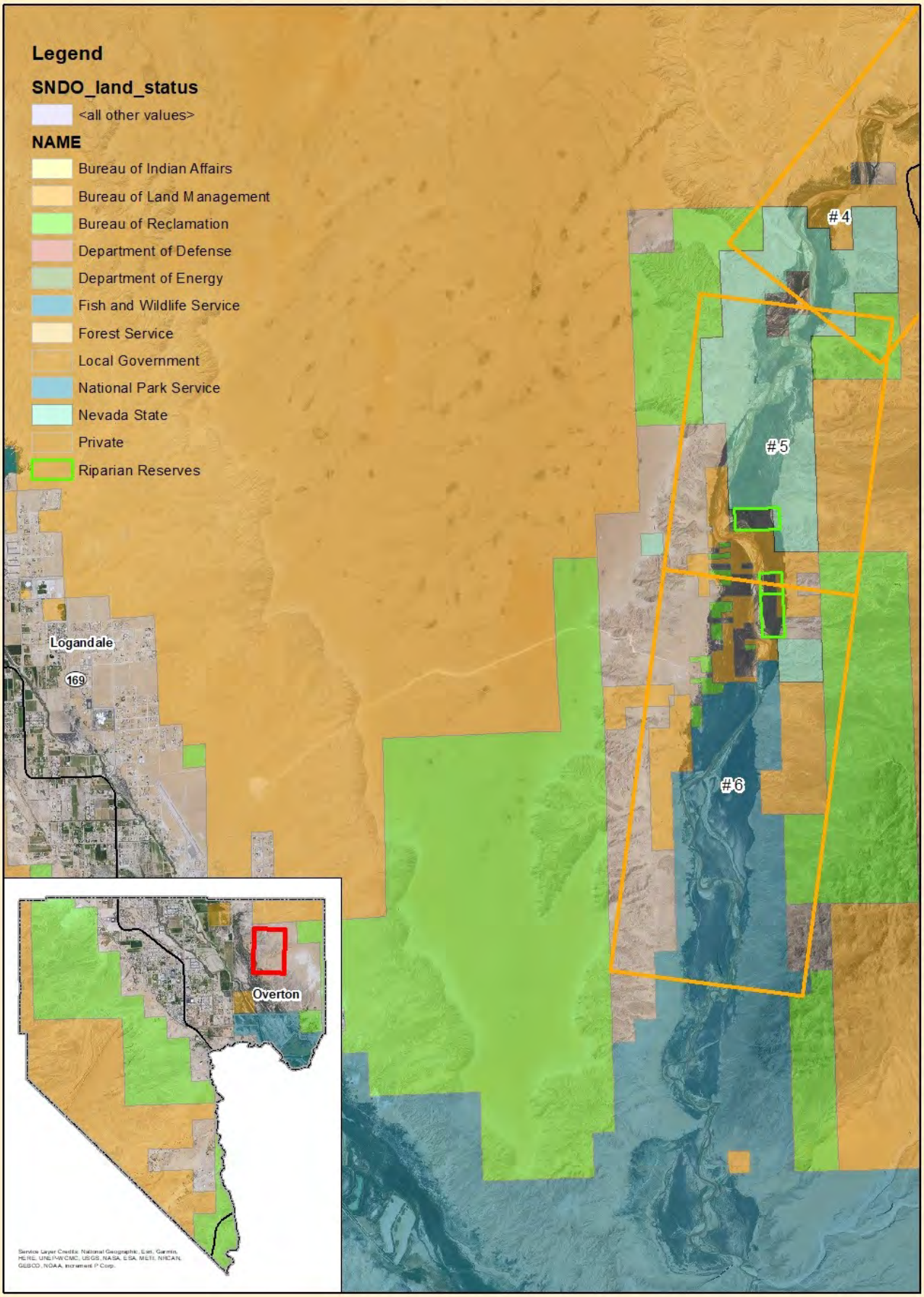


Bureau of Land Management
Private
Reserve Reach

Virgin River Reserve
Riverside
Land Ownership
Figure 5

0 0.125 0.25 0.5
Miles

Coordinate System: UTM Zone 11
Datum: NAD83
Date: 7/1/2021
Name: Riparian_Management_virgin



Virgin River Reserve Mormon Mesa & Mormon Mesa South Land Ownership Figure 6

0 0.5 1 2 3
Miles

Coordinate System: UTM Zone 11
Datum: NAD83
Date: 05/1/2023
Name: Riparian_Management_virgin

2.2.3 Geology and Soils

The majority of the soil types on the Virgin River sites consist of alluvium soils (Natural Resources Conservation Service 2015). The soils in the river channel (Riverwash – Water Complex) consist of gravelly coarse sand with clay in the lower soil profile. These soils experience frequent flooding and are poorly drained, with water at or within 2 feet of the soil surface. The vegetated floodplain stream terrace soils (predominantly Oxyaquic Torriorthents – Toquop Complex, Toquop Complex, and Toquop Fine Sand) consist of fine sandy loam and silty clay loams, and experience frequent flooding and are poorly drained. These soils can be productive farmland soils, known as loamy bottoms. Soils can be slightly to strongly saline depending on the source of the alluvium (Orr et al. 2013b, Natural Resources Conservation Service 2015). The pH of these soils ranges from 8 to 9 (Orr et al. 2013b).

To the southeast of the Bunkerville and Mesquite sites on a higher floodplain terrace is the Virgin River silty clay soil series. This soil is calcareous alluvium derived from sedimentary rocks and are silty clay and clay loams that are somewhat poorly drained and are slightly to strongly saline. These soils are considered farmland of state significance in Nevada.

The upland soils of the Mormon Mesa parcel are excessively well drained and do not experience flooding. On the eastern uplands the soils are primarily in the Sweetwater-Carrizo Association. These soils are found on the summits and drainage ways of fan remnants and are extreme gravelly loam with high calcium and moderate salinity. The western uplands are dominated by three soil types: Arada fine sands along the river (found on fan remnants and eolian in origin), badland soils on the slopes (shallow colluvium and exposed rock), and the Mormon Mesa soil series (lacustrine soils with a petrocalcic layer) on the upper flats.

The soils of the Virgin River Reserve reflect the geology of the surrounding mountains. To the south are the Virgin Mountains, with the highest elevations reaching nearly 6,500 feet. The rocks range in age from Precambrian to Tertiary. The Precambrian rocks consist of a metamorphic and igneous complex, marine carbonate rocks with subordinate, fine-grained clastic material represent the Paleozoic Era, and the Mesozoic and Cenozoic rocks consists of continental and marine deposits of siltstone, sandstone, limestone, gypsum, conglomerate, and shale. To the north is Mormon Mesa, a flat-topped unit that rises over 650 feet above the Virgin River. The cap of the mesa is part of the Muddy Creek Formation, deposited between 12 and 4 million years before present, with the petrocalcic layers of the formation originating toward the end of that period (Brock and Buck 2009).

2.2.4 Topography

The topography of the Virgin River Reserve is relatively flat, with approximately 15 feet of elevation change within the floodplain (river channel, active alluvium, and vegetated alluvium) to over 30 feet of elevation change between the floodplain and the surrounding uplands (Orr et al. 2013b). The boundary between the floodplain and the upland is steep, with elevations ranging from 1,260 to 1,600 feet.

2.2.5 MSHCP-Covered Plant Species

A limited inventory of plants has occurred within Virgin River Reserve. The Mormon Mesa site had a plant inventory to document native and nonnative plants conducted in the fall of 2013 by Stillwater Sciences and the University of California, Santa Barbara. Surveys to inventory MSHCP-covered plant species within the other Virgin River Reserve sites have not been conducted. No covered, evaluation, or watch list plant species are known to occur. A complete list of native plant species observed in the Virgin River reserve unit is included in Appendix C.

2.2.6 MSHCP-Covered Avian Species

Avian surveys have been conducted annually on Virgin River Reserve sites since 2017.

The following MSHCP-covered species (or evaluation species) have been observed since 2017, listed by site (SWCA 2017a, SWCA 2017b, SWCA 2019, SWCA 2020, SWCA 2021, SWCA 2022):

Mesquite—southwestern willow flycatcher, yellow-billed cuckoo, Arizona Bell's vireo, and crissal thrasher (evaluation species)

Bunkerville East—blue grosbeak and Arizona Bell's Vireo, and crissal thrasher (evaluation species).

Bunkerville West—yellow-billed cuckoo, vermilion flycatchers, phainopepla, blue grosbeak, Arizona Bell's vireo, willow flycatcher (See SWCA 2020 for explanation), and crissal thrasher (evaluation species).

Riverside—blue grosbeak, Arizona Bell's vireo, phainopepla, willow flycatcher (See SWCA 2020 for explanation), and crissal thrasher (evaluation species).

Mormon Mesa—southwestern willow flycatcher, yellow-billed cuckoo, blue grosbeak, Arizona Bell's vireo, summer tanager, and crissal thrasher (evaluation species).

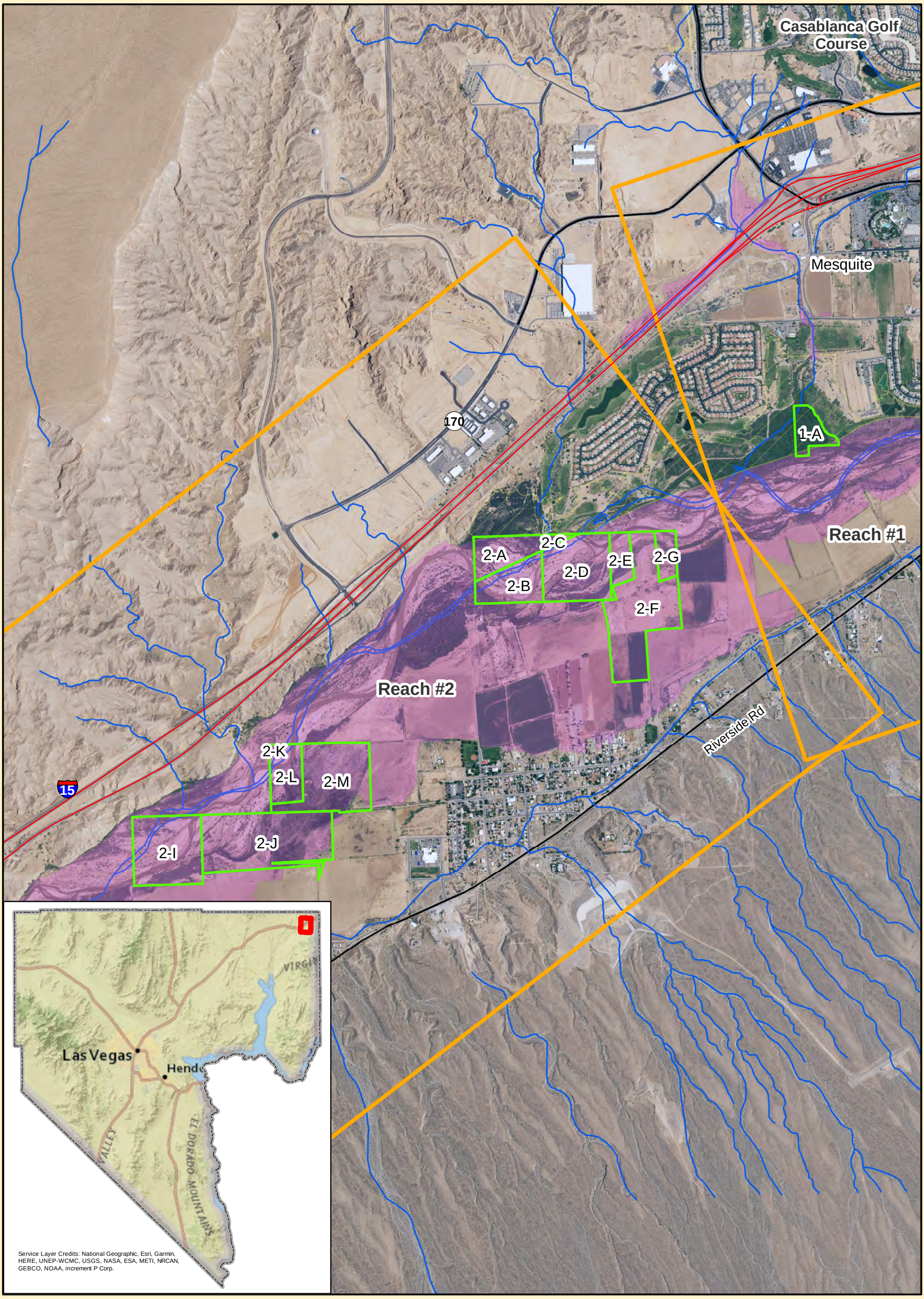
2.2.7 Water Resources

Surface Water and Groundwater

The Virgin River is a perennial tributary of the Colorado River, arising in southwestern Utah, flowing through northwest Arizona and southern Nevada, and emptying into Lake Mead. The river is approximately 162 miles long, with the last 30 miles forming the north arm of Lake Mead. Water resources for each parcel in the Virgin River Reserves are shown in Figure 7, Figure 8, and Figure 9.

The river has a relatively natural hydrologic regime, with only a few low-water dams in the upper reaches in Utah and local water withdrawal for agriculture in Nevada (Dixon and Katzer 2002). The annual river flow averages 140,000 AFY, which is a combination of river and spring flow and groundwater loss. The annual flow has ranged from 78,000 to 500,000 AFY between 1930 and 1998. Monthly flows are between 100 and 150 cubic feet per second (cfs) from June to October, increasing in volume from winter through spring with highs over 400 cfs in April and May. Shallow sub-surface water flow is generally parallel with the floodplain (Orr et al. 2013b).

No water rights were attached to or conveyed with parcels in the Virgin River Reserve, but there may be opportunities to lease water from the Mesquite or Bunkerville Irrigation Districts if needed to support restoration activities.



Legend

- Riparian_Reserves
- HUC Reaches

FEMA Flood Zone

FZONE

- ZONE A
- ZONE AE
- ZONE AO
- FEMA Rivers and Washes

Virgin River Reserve Mesquite and Bunkerville Water Resources Figure 7

0 0.25 0.5 1

Miles

Coordinate System: UTM Zone 11
Datum: NAD83
Date: 7/1/2021
Name: Riparian_Management_virgin

N W E S

15
170
2
3
3-A
3-B
Las Vegas
Hend
VALLEY
EL DORADO MOUNTAINS
Service Layer Credits: National Geographic, Esri, Garmin, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Legend

- Riparian_Reserves
- HUC Reaches

FEMA Flood Zone

FZONE

- ZONE A
- ZONE AE
- ZONE AO
- FEMA Rivers and Washes

Virgin River Reserve
Riverside
Water Resources
Figure 8

0 0.25 0.5 1
Miles

N W E S

Coordinate System: UTM Zone 11
Datum: NAD83
Date: 7/1/2021
Name: Riparian_Management_virgin

#5

5-A

6-A

6-B

#6

Legend

- Riparian Reserves

FEMA Flood Zone

FZONE

- ZONE A
- ZONE AE
- ZONE AO
- HUC Reaches

Virgin River Reserve Mormon Mesa and Mormon Mesa South Water Resources Figure 9

0 0.125 0.25 0.5

Miles

Coordinate System: UTM Zone 11
Datum: NAD83
Date: 6/21/2023
Name: Riparian_Management_virgin

2.2.8 Site Narratives and Restoration Priorities

The following descriptions for each set of Virgin River properties are based on staff observation, field notes, and reports from contractors performing surveys on each parcel. Information varies for each site and parcel due to factors such as: length of time the property has been owned by Clark County, access to property, number of ongoing and/or past projects, etc. The following narratives are intended to describe conditions at each site and provide general rationale for the types of restoration activities that are recommended.

Restoration priorities are based on specific site conditions, as well as the stressors described in Section 1.8. For example, all parcels include 'tamarisk treatments' as a restoration priority because tamarisk is an invasive species described in Section 1.8 that is widespread throughout the riparian reserve properties and has known negative ecological impacts. Similarly, fence installation is recommended for all Virgin River properties because livestock trespass in specifically noted in Section 1.8 as being prevalent near all Virgin River reserve parcels.

Mesquite:

Mesquite (sometimes referred to as Mesquite West) consists of one 11.49-acre parcel in Reach 1.

There is extensive willow habitat and this site is located in southwestern willow flycatcher territory.

Restoration priorities include select noxious weed treatments.

Bunkerville East:

Bunkerville East consists of 153.54 acres in seven parcels labeled 2-A through 2-G based on physical location from west to east. The parcels are located in the town of Bunkerville across from the southwest corner of the Casablanca Golf Course in Mesquite. This site includes the active floodplain of the Virgin River, with the river cutting through the site from east to west. A historic levee is also present on the south side of the river.

Vegetation at the site are mosaics of varying types and sizes. Approximately 3.5 ha consists of various sparse mixtures of arrowweed (*Pluchea sericea*), tamarisk (*Tamarix spp.*), seep willow (*Baccharis salicifolia*), and screwbean mesquite (*Prosopis pubescens*), all of which were < 3 meters (m) in height. Information collected during bird surveys indicated three general types: 1) relatively contiguous tamarisk 3–5 m in height with canopy closure 60%–80%, 2) a mix of tamarisk and screwbean mesquite 3–5 m in height with canopy closure up to 50%, and 3) strips and clumps of tamarisk up to 4 m in height with an understory of arrowweed and canopy closure < 40%. Individual Goodding's willows (*Salix gooddingii*) 8–10 m in height were present along the bank of the Virgin River in the southwestern corner of the parcel.

During this same survey, canopy height within each stand was described as uneven and the tops of many of the tamarisk plants appeared dead, likely as the result of repeated defoliation by tamarisk leaf beetles (*Diorhabda carinulata*). Both adult and larval beetles were detected at the site, and the tamarisk were partially defoliated.

Restoration priorities include levee dispersal, tamarisk removal and revegetation, and fence installation.

Bunkerville West:

Bunkerville West consists of 160.67 acres in five parcels, labeled 2-I through 2-M. The parcels are located in Bunkerville, west of the terminus of Vincent Leavitt Avenue. The parcels newly

acquired in 2020 do not have descriptions available yet. Additional narrative information including them will be added in the next management plan revision (expected revision in 2023).

The river cuts through parcel 2-H and is known to have smaller tributary/channels with both active and inactive beaver dams.

Scattered willows occur in this site and there appears to be a high potential for more willows in the old beaver dam pond and marsh habitat.

Restoration priorities include levee dispersal, tamarisk removal and revegetation, and fence installation.

Riverside:

The approximate 140 acres owned in Riverside can be characterized as having an active Virgin River floodplain. Upland plants present include tamarisk, threecorner milkvetch, sticky buckwheat, Nye milkvetch, and limestone violet. Other vegetation includes arrowweed (*Pluchea sericea*), Mesquite, and some willows are on site.

Restoration priorities include tamarisk removal, subsequent revegetation, and fence installation.

Mormon Mesa:

The 80-acre Mormon Mesa property is on the east side of the Virgin River and includes a scour area along the western bank. Its river and floodplain habitat is adjacent to existing breeding habitat for southwestern willow flycatcher.

During site visits in 2017, surface water and saturated soils were observed in late spring in channels on the eastern third of the site and had dried to damp soil by July. The southwestern portion of the property was scoured during the December 2010 flood event, leaving a mix of open water and wet-moist riverwash sediments that have been colonized in some areas by wet meadow species and tamarisk.

The property is currently dominated by dense stands of nonnative tamarisk shrubland, primarily *Tamarix ramosissima* (or the hybrid form *T. ramosissima x chinensis*). The tamarisk dominated areas consist primarily of dense, monotypic tamarisk 3–5 m in height that is 80%–90% dead as the result of repeated defoliation by tamarisk leaf beetles. In the western half of the site, several small plots were cleared of tamarisk in the fall of 2013 and subsequently planted with willows and other native species (SWCA 2020b).

Other vegetation at the site consists of willows and other native species found in small patches, generally in wetter areas. The southwestern edge of the site is sparsely vegetated by Goodding's willow, tamarisk, and arrowweed (*Pluchea sericea)*, all < 3 m in height. Mesquite and other native shrubs are scattered in a narrow zone of transition from the floodplain to the upland along the eastern edge of the property.

Restoration priorities include MSHCP-covered bird habitat enhancement, especially given that the parcel is adjacent to southwestern willow flycatcher breeding habitat; continued tamarisk removal and treatments; and fence installation.

Section 3 Management Goals, Objectives, and Actions

The management goals for the Riparian Reserves are based on the Section 10 incidental take permit and the guiding documents for the reserves.

3.1 Management Goals and Objectives

Management goals are broad, general statements to establish the direction for the management of the easement. **Management objectives** provide further explanation regarding the intent of the management goals and are established to measure progress towards achieving management goals for the Boulder City Conservation Easement (BCCE). Management goals and objectives are presented in Table 6 These management goals and objectives are related to, but not identical to, the Biological Goals and Objectives (BGO) that were drafted in 2016 (Clark County 2016). The BGOs are used to quantitatively gauge implementation and success of specific projects conducted under the MSHCP. Specific management actions listed in Section 3.3 are linked to both the management goals and objectives as well as the biological goals and objectives.

Table 6. Riparian Reserves Management Goals and Objectives

Goal 1	**Manage reserves to provide habitat for the six MSHCP covered avian species**
Objectives	*1.0 Restore, create, and enhance habitat for riparian bird species*
Goal 2	**Manage reserves to support resource values for other MSHCP and sensitive species when practicable**
Objectives	*2.0 Manage habitat to avoid harm to aquatic species*
Goal 3	**Manage reserves to meet conservation and landowner obligations**
Objectives	*3.0 Control invasive plant species and noxious weeds*
	4.0 Reduce threat of fire and maintain safe conditions
	5.0 Manage property rights and property infrastructure
	6.0 Build and maintain positive relationships in the community
Goal 4	**Expand property holdings of desert riparian habitats for MSHCP covered species**
Objectives	*7.0 Acquire title to private lands from willing sellers*
	8.0 Acquire conservation easements to public and private lands with willing landowners as appropriate

3.2 Discussion of Objectives and List of Management Actions

Objectives are what guide identification and development of management actions and day-to-day activities. Management actions are defined as specific actions, methods, or tools by which objectives are met and goals are achieved. This section provides a general discussion of each objective and lists management actions that would meet each objective. Section 3.3 contains the table of management actions with further details on what, where, when, and who implements each action, and how to measure effectiveness of implementation of the action.

Objective 1.0 - Restore, create, and enhance habitat for riparian bird species

Desert riparian habitats have been significantly reduced in extent by development, agriculture, fire, and the lowering of the local and regional aquifers, and reduced in quality primarily by the invasion of tamarisk. The restoration, creation, and enhancement of desert riparian habitats is necessary for survival of MSHCP-covered riparian bird species. There is substantial experience among agencies, consultants, and within the DCP on how to restore riparian habitat.

The management actions that will restore, create, and enhance habitat for riparian bird species include:

1.1 Identify and prioritize sites for restoration

1.2 Develop restoration plans for priority restoration sites

1.3 Implement restoration plans

1.4 Monitor and adaptively manage restored riparian habitat

1.5 Collaborate with others to manage riparian habitat restoration along the Muddy and Virgin rivers

1.6 Assess opportunities to obtain water from irrigation districts to support restoration

1.7 When feasible, assess opportunities to establish in-lieu fee agreement with U.S. Army Corps of Engineers for Clean Water Act permit mitigation options

Objective 2.0 - Manage habitat to avoid harm to aquatic species

The Muddy and Virgin rivers have several aquatic fish and invertebrate species that are of federal or state significance and that are not MSHCP-covered species. Among these are the federally listed endangered Moapa dace on the Muddy River and the woundfin on the Virgin River, and the federally listed endangered Virgin River chub, found in both rivers. Activities related to the restoration, creation, and enhancement of riparian habitat should be conducted in such a way to reduce impacts to the river channel that could affect aquatic species and in accordance with all laws and regulations. Additionally, other management actions such as invasive species control and removing underground utilities should also be conducted so that impact to aquatic species is minimized.

The management actions that will manage habitat to avoid harm to aquatic species include:

2.1 Coordinate with the USFWS on management actions to avoid negative effects to aquatic species

Objective 3.0 - Control invasive plant species and noxious weeds

Saltcedar (Tamarisk sp.) is the primary invasive plant species on the Riparian Reserves. Some of the other non-native plant species on the Muddy River Reserve identified during a botanical inventory and mapping project (2005-NPS-561N) completed in 2012 included Malta star thistle, Australian saltbush, African mustard, Russian knapweed, red brome, and cheatgrass. Noxious weeds, camelthorn and tall whitetop, are also present on the Virgin River Reserve, Mormon Mesa parcel. See Section 1.6.2 for additional information.

These species can spread rapidly along riparian corridors and displace native species. The DCP, as a landowner, is required under the NRS to control the spread of noxious weeds. The DCP is assisted by the National Park Service Lake Mead Exotic Plant Management Team (project 2017-NPS-1720A) to control and manage non-native plant species on the Riparian Reserves.

The management actions that will control invasive plant species include:

3.1 Conduct control activities for invasive species and noxious weeds

3.2 Adaptively manage the control of invasive species and noxious weeds

Objective 4.0 - Reduce threat of fire and maintain safe conditions

One of the most destructive threats to the ecosystems of the Mojave Desert is the occurrence of fire. Fires reduce or eliminate riparian trees and shrubs and thus reduce the vegetation structure required by all riparian bird species. Frequency of fire in the Mojave Desert is related to the availability of fuels, the source of which is primarily non-native invasive plant species. The control of non-native invasive plant species assists in reducing fire. Firebreaks, strips where all

flammable vegetation is cleared, are effective in reducing the spread of fire and protecting the natural and human resources. The DCP has removed and trimmed non-native palm trees (sources of fuel) and has established and maintains fire breaks on several of the Muddy River Reserve parcels.

The management actions that will address reducing the threat of fire include:

4.1 Control of non-native invasive plant species to reduce fuel availability

4.2 Maintain existing fire breaks and establish new firebreaks when necessary

Objective 5.0 - Manage property rights and property infrastructure

For purposes of this objective, property rights and infrastructure address those rights, structures, utilities, easements, and roads that were acquired by the DCP along with title to the land.

Groundwater rights were attached to Muddy River Reserve Parcels C through F, and a house (since demolished) was included with Parcel B. The house was serviced by a municipal water connection from the Moapa Valley Water District and electrical from Overton Power. Some infrastructure must be maintained to support the conservation obligations of the reserves. The certificated groundwater rights have been updated in the County's name. This objective also addresses property rights and infrastructure held by others that are used indirectly to manage the Riparian Reserves.

The management actions that will address property rights and property infrastructure include:

5.1 Update title to and use of groundwater rights

5.2 Maintain functional municipal water connection and maintain pump equipment

5.3 Identify presence and location of operational and abandoned underground utilities (water, sewer, electric)

5.4 Maintain fences, as needed, and add additional fences if needed

5.5 Obtain permission to cross private lands to access reserves

5.6 Identify options for road access to the Virgin River Reserve, Subunit 1

5.7 Maintain road access to the Muddy River Reserve

5.8 Maintain relationships and coordinate with adjacent landowners to protect conservation values of the reserves

Objective 6.0 - Build and maintain positive relationships in the community

In achieving conservation obligations, it is important to ensure that the DCP and the County maintains a positive relationship with the local neighbors and community as a whole. Currently, the Riparian Reserves are not open to public use, but it is important that the public understands the purpose for the Riparian Reserves, knows the allowable and prohibited uses, and can locate the physical extent (boundaries) of the reserves. Information can be provided through personal interactions, signage, interpretive materials, kiosks, and the DCP webpage.

The management actions that can help maintain community relationships for the Riparian Reserves include:

6.1 Maintain positive interactions with neighbors

6.2 Perform general maintenance on reserves as needed

6.3 Be responsive to community concerns related to the reserves

6.4 Prepare public information material that provides information to the public

Objective 7.0 - Acquire title to private lands from willing sellers

The incidental take permit requires the acquisition and management of riparian properties, specifically Condition K.1 requires the "acquisition of private lands in desert riparian habitats" along the Muddy River, Virgin River, and Meadow Valley Wash for covered avian species. Acquisition can be by purchase, exchange, transfer or donation.

The management actions to pursue acquisition of private lands from willing sellers include:

7.1 Identify priority parcels for purchase using Acquisition Selection Tool

7.2 Ensure clear title to property before proceeding with acquisition

7.3 Pursue acquisition of priority parcels

7.4 Pursue transfer of parcels held by local and state entities when available

Objective 8.0 - Acquire conservation easements to public and private lands from willing landowners as appropriate

The incidental take permit requires the acquisition and management of riparian properties. Although Condition K.1 specifically requires the acquisition of "private lands" in desert riparian habitats along the Muddy River, Virgin River, and Meadow Valley Wash, opportunities for entering into conservation easements on public lands in addition with private landowners may also be an option.

The management actions to pursue conservation easements to public and private lands from willing landowners include:

8.1 Identify priority parcels for easements using Acquisition Selection Tool

8.2 Develop a conservation easement template

8.3 Pursue easements of priority parcels

3.3 Management Actions and Effectiveness Measures

The primary purpose of a management plan is to provide guidance for selecting management actions that support or meet management objectives, and ultimately achieve management goals. The management actions for the Riparian Reserves have been identified from day-to-day management operations, as well as other actions necessary to meet the objectives and goals for managing the reserves.

Table 7 includes the management objectives (noted as 1.0, 2.0, etc.) and the management actions (1.1, 1.2, 2.1, 2.2, etc.) related to each management objective. Some management actions can fulfill more than one objective and are noted in parentheses after the management action title. Management actions can be separate individual activities or be interrelated with other actions and sequential in implementation.

Each management action is presented in Table 7 by the columns that include:

- Management Action Description: a brief description of what the action entails and why it is important.
- Reserve Parcel or Location: the location in the particular reserve and reserve parcel(s) where the management action will take place.

- Timeframe: the year or time period in which the action will take place, such as weekly, quarterly, 2015, or one year after a previous management action is complete.
- Lead: the agency or entity that is responsible for implementing the management action.
- Permit(s): the approvals, written permissions, or permits required to initiate the management action.
- Priority: the importance of the action in meeting the management objectives and determines the priority for resources.
    - VH (very high): an action that is essential for meeting the management objective and requires immediate implementation to protect the resource.
    - H (high): an action that is essential for meeting the management objective and requires implementation in the near future to protect the resource.
    - M (medium): an action that is important but not essential for meeting the management objective or protecting the resource and does not require implementation in the near future.
    - L (low): an action that is not essential to meeting the management objective or protecting the resource and can be delayed until funding is available.
- Cost: an estimate of the financial cost (DCP labor, contractor labor) to complete the management action, and generally coincides with Clark County contracting and acquisition limits.
    - L (low): < $25,000
    - M (medium): $25,000 to $50,000o H (high): $50,000 to $100,000
    - VH (very high): > $100,000
- Effectiveness Measures: a listing of metrics to be measured to assess the effectiveness (success) of the management action.
- Frequency (of Effectiveness Measures): when the effectiveness measures are reviewed, ranging from monthly to the end of a specific project.
- Status: current status and tracking of the management action.
- BGO: A list of the Biological Goals and Objectives addressed by the management action. Some management actions are not associated with a BGO because there is no direct connection for the action supporting a specific BGO. These actions support management and stewardship of the riparian reserves and thus generally support all of the BGOs.

The management action table is a tool to guide day-to-day management activities and is intended as a working document for the DCP to update, add to, and/or change actions as conditions warrant.

Each update to the table should be tracked by entering a current date in the footer of the table.

Table 7. Management Actions and Effectiveness Measures

	Management Goals and Objectives	Management Action Description	Management Effectiveness Measures	Related BGO
1	**Restore, create, and enhance habitat for covered species**	-	-	-
1.1	Identify and prioritize locations for habitat restoration and enhancement	Determine sites that have the greatest potential for restoration and result in the most contiguous habitat	Completed assessment of sites for restoration	1.3
1.2	Develop restoration plans for priority restoration sites	Establish restoration goals and objectives, assess site condition and restoration potential, restoration design includes plant materials, planting methods, and weed control; incorporate natural riparian processes wherever possible	Plans are complete with goals and objectives for restoration and with all components needed for implementation	1.4
1.3	Implement restoration plans	Implement restoration plans; prepare scope of work/contract; clear vegetation, plant vegetative materials as designed, and fence restoration sites to eliminate cattle trespass, if needed.	Implementation meets restoration goals and objectives, contract requirements	1.3
1.4	Monitor and adaptively manage restored riparian habitat	Establish success criteria and monitoring schedule; assess success of restoration/enhancement against criteria; continue/augment restoration actions to maintain investment; further discussion is available in the Adaptive Management and Monitoring Plan (Alta 2023)	Restoration/enhancement plantings and topographic modifications meet success criteria	1.3

Table 7. Management Actions and Effectiveness Measures

	Management Goals and Objectives	Management Action Description	Management Effectiveness Measures	Related BGO
1.5	Collaborate with other agencies and entities to manage riparian habitat restoration along the Muddy and Virgin Rivers	Collaborate with other agencies for sharing of information on successes, failures, and techniques	Knowledge is shared supportive of habitat restoration	3.1
1.6	Assess opportunities to obtain water from irrigation districts to support restoration	Water from irrigation districts could be used in restoration projects to increase survival of planted materials	Assess quality and quantity of planted materials because of water obtained from irrigation districts for conservation purposes.	1.3
1.7	When feasible, assess opportunities to establish in-lieu fee agreement with U.S. Army Corps of Engineers for Clean Water Act permit mitigation options	Discuss requirements for in-lieu fee agreement with Corps; assess options and locations for establishing agreement	Decision to pursue in-lieu fee agreement	1.3
2	**Manage habitat to avoid harm to aquatic species**			
2.1	Coordinate with USFWS on management actions to avoid negative effects to the Moapa dace population	Obtain input from USFWS on management actions that may impact the river system. Determine which management actions require input from USFWS.	Negative effects from restoration and land management are avoided	1.3
3	**Manage reserve units to control invasive plant species and noxious weeds**			
3.1	Conduct control activities for invasive species and noxious weeds	Prepare contracts, schedule, and implement control activities	Treatment/eradication is completed and meets goals and objectives or plan and contract requirements	1.1

Table 7. Management Actions and Effectiveness Measures

	Management Goals and Objectives	Management Action Description	Management Effectiveness Measures	Related BGO
3.2	Adaptively manage the control of invasive species and noxious weeds	Establish monitoring schedule; assess success of treatment/eradication against criteria; schedule additional treatments as needed	Monitor to area and/or numbers to assess eradication or reduction	1.1
4	**Manage reserve units to reduce threat of fire and maintain safe conditions**			
4.1	Maintain existing fire breaks and establish new fire breaks when necessary	Fire breaks control the spatial spread of fire and protects the conservation values of the parcels and the property of adjacent landowners. Prepare contracts, schedule, and implement the maintenance or establishment of fire breaks.	Fire breaks control the spatial spread of fire and protects the conservation values of the parcels and the property of adjacent landowners	1.3
5	**Manage property rights and property infrastructure**			
5.1	Update title to and use of groundwater rights	The certificated groundwater rights must be changed for title and for use for wildlife purposes.	Groundwater rights are certificated to Clark County for wildlife uses	1.3
5.2	Maintain functional municipal water connection and maintain pump equipment	Inspect Moapa Valley Water District water connection backflow device, pay monthly connection fees	Functional municipal water connection that meets restoration needs	1.3
5.3	Identify presence and location of operational and abandoned	Determine likely locations for utilities; prepare contract, schedule, and	Presence and location of underground utilities are identified	1.3

Table 7. Management Actions and Effectiveness Measures

	Management Goals and Objectives	Management Action Description	Management Effectiveness Measures	Related BGO
	underground utilities (water, sewer, electric)	implement action to search and assess the underground utilities.		
5.4	Maintain existing fencing and add additional fencing if needed	Inspect existing fencing on a continual basis, repair fences when needed; assess reserve units for additional fencing needs and installation as needed	Location, length, and percent of fencing inspected. Length and percent of fencing needing repair. Completion of repairs, time period between notification and repair.	1.3
5.5	Obtain permission to cross private lands to access reserve units	Determine the timing, frequency, and extent of access needed; contact owners of property where access is needed; obtain written permission for access	Permission is obtained to cross private lands to access properties	1.3
5.6	Identify options for road access to Virgin River Reserve Unit, Subunit 1	Determine the timing, frequency, and extent of access needed; contact owners of property where access is needed; obtain written permission for access	Road access is obtained to Virgin River Parcel 1	1.3
5.7	Maintain road access to the Muddy River Reserve Unit	Monitor condition of access roads; determine type of maintenance needed for safe conditions; conduct maintenance. Weekly to parcels A-E, monthly F-I	Road access is maintained to all Muddy River Reserve Unit parcels	1.3
5.8	Maintain relationships and coordinate with adjacent landowners to protect conservation values of the reserve units	Communicate (formal and/or informal, as appropriate) with landowners regarding property management actions, issues, and ongoing and pending projects	Relationships with adjacent landowners is reviewed annually	1.3

Table 7. Management Actions and Effectiveness Measures

	Management Goals and Objectives	Management Action Description	Management Effectiveness Measures	Related BGO
6	**Build and maintain positive relationships in the community**			
6.1	Maintain positive interactions with neighbors	Engage with neighbors when safely provided the opportunity	Good relationship is maintained	3.1
6.2	Perform general maintenance on reserve units as needed	Identify and implement maintenance activities, direct maintenance contractor as needed	Maintenance activities are performed	1.3
6.3	Be responsive to community concerns related to the reserve units	Listen to and respond to concerns from members of the community if appropriate	Community concerns are addressed	3.1
6.4	Prepare public information material that provides property information to the public	Public information can include Riparian Reserves Management Plan, webpage updates, signs, interpretive materials that discuss allowable uses, property boundary, resource values and purpose	Current webpage and other materials	3.1
7	**Acquire title to private lands from willing sellers**			
7.1	Identify priority parcels for purchase using Acquisition Selection Tool	Use the Acquisition Section Tool to assess the priority of parcels when offered by willing sellers; prioritize patches that enhance landscape-level habitat connectivity	Properties offered by willing sellers are assessed with the Acquisition Selection Tool within 3 months of being offered and a decision on acquisition provided within 6 months of being offered	1.2
7.2	Ensure clear title to property before proceeding with acquisition	Coordinate with County Surveyor to review property boundaries and deeds	Decision on clear title from County Surveyor	1.2

Table 7. Management Actions and Effectiveness Measures

	Management Goals and Objectives	Management Action Description	Management Effectiveness Measures	Related BGO
		to ensure clear title; review cadastral survey when complete		
7.3	Pursue acquisition of priority parcels	Conduct appraisal, determine fair market value, make offer, negotiate as needed	Decision on acquisition	1.2
7.4	Pursue acquisition of parcels held by local and state entities when available	Identify parcels held by County Treasurer or other Departments, other municipalities, or state; discuss planned or future needs for parcels to determine best use or benefit to County; transfer management responsibility to DCP.	Decision on acquisition	1.2
8	**Acquire conservation easements to public and private lands from willing landowners as appropriate**			
8.1	Identify priority parcels for conservation easements using Acquisition Selection Tool	Evaluate feasibility of conservation easement; use the Acquisition Section Tool to assess the priority of parcels when offered by willing sellers; prioritize parcels that enhance landscape-level habitat connectivity	Easements offered by willing landowners are assessed with the Acquisition Selection Tool	1.2
8.2	Develop a conservation easement template	Develop an easement template that outlines approved and prohibited actions, access for monitoring, and communication schedule	Completed conservation easement template	1.2

Table 7. Management Actions and Effectiveness Measures

	Management Goals and Objectives	Management Action Description	Management Effectiveness Measures	Related BGO
8.3	Pursue easements of priority parcels	Negotiate terms of easement.	Decision on easements provided within 12 months of being contacted	1.2

Section 4 Considerations for Future Versions of the Riparian Management Plan

Suggestions that may be considered prior to the next revision of the Riparian Reserve Management Plan are listed below. These suggestions are a compilation from multiple Science Advisor Panel members and likely would not all work if implemented at the same time. The following suggestions are primarily intended to spur discussion prior to the next revision.

- Providing additional content and context for each site. Sections 2.1.9 and 2.2.9 include narratives of each site, but the amount of information available (and written) for each site varies greatly. A similar suggestion is to provide photos of each site to illustrate site conditions and ongoing restoration projects.
- Consider grouping parcels by intended management actions instead of by those that are contiguous or adjacent.
- As additional parcels are acquired, consider a separate management plan for each watershed. If this were pursued, we encourage considering splitting background and historical information that is less relevant on a day-to-day basis into its own stand-alone document and focusing the management plans solely on the management goals, objectives, and actions, including progress updates and rationale for each.
- Consider providing more information on each management action (and therefore, each restoration project) including progress, outcomes, next steps, etc. This information would likely be part of the site narrative for each grouping of parcels. This suggestion lends itself to more frequent updates to management plan (contrary to the suggestion immediately below).
- Consider decreasing the interval of revision to the document, but do not remove the clause that the management plan may be updated whenever new information that influences management is available (e.g., new parcels are acquired). Extending the timeline of regular updates will facilitate taking a ‘hard look’ at the management plan and making major management or management strategy updates.

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Appendix A
Access to Reserves

Muddy River Access

The Muddy River property consists of nine parcels in the Moapa Valley. The primary access is via Interstate 15 (I-15) north to State Route (SR) 168 at Glendale, north to Warm Springs Road, and then west to a gated drive past Palm Creek RV Park on the west bank of the Muddy River for parcels A and B. Continue farther west on Warm Springs Road to Hillside Drive for parcels C through F (Figure 1).

The route to parcels G through I is south from Warm Springs Road on Sim Street, east on Marley Way, and then south on Saltbrush Lane to the access road along the flood channel, then hike into parcels. The preferred route is east on Learned Cactus Way from Saltbrush Lane to a gated unimproved trail that heads south across private property to Parcel G (Figure 1).

Virgin River Access

Mormon Mesa: West access: Take I-15 north to SR 168 at Glendale, south on SR 168 (Moapa Valley Boulevard) through Logandale and Overton, then north on Cooper Street to Mormon Mesa Road and past the duck club on a private dirt trail (Figure 5).

Access from the east is via I-15 south to SR 170 (Riverside Road), southwest on Gold Butte Road, and then west on a dirt trail through a wash to the river.

Bunkerville East: Parcels A-G can be accessed from Riverside Road to E. Virgin Street, northeast to Canal Street, north on Cemetery Road for approximately 0.25 mile to a locked gate.

Alternative access: I-15 north to SR 170, northeast on Riverside Road to Second West Street, north to the end of the pavement and continue on the unimproved section line, east on an unimproved road to the flood channel right-of-way, and then north to the river (Figure 8).

Bunkerville West: Access via a dirt access road west of First South Street. Riverside: Take I-15 north to exit for SR 170 to River Cliff Road.

Mesquite: May be accessed via foot through the southwest end of Coyote Willows Golf Course.

Appendix B

Acquisition Selection Tool

Acquisition Selection Tool – Criteria and Questions

An acquisition selection tool was developed by the Desert Conservation Program (DCP) to guide decisions for acquiring title or easement to riparian properties from willing sellers and landowners. The tool is used to rank and prioritize properties based on specific environmental and administrative criteria, and the values derived by responding affirmatively or negatively to a series of questions that further define, describe, and explain each criterion. The criteria and questions are applied to each prospective property to arrive at a total value and then assigned a priority of 1, 2, or 3 based on what value range the property falls within. The criteria and questions and example value matrix are presented here.

Administrative Criteria

- Ease of Management
  - Are lands difficult to access due to legal issues, safety or other reasons?
  - Are lands difficult to access due to difficult terrain?
  - Are there known land use practices, such as grazing, occurring on adjacent lands that will negatively affect habitat or species?
  - Does the property need a fence to keep out cattle?
  - Are agreements needed for water with irrigation districts or others?
- Complexity of Land Acquisition Process
  - Are there existing structures?
  - Is an environmental assessment likely needed due to underground storage tanks or other reasons?
  - Will the desired property require further parceling?
  - Will an additional private survey need to be conducted?
  - Is the property held in limbo due to the cadastral survey?
- Potential for Degradation of Habitat if not Purchased for Conservation
  - Is habitat in identified flood scour zone?
  - Is the habitat reasonably protected from degradation from existing or potential future land practices?

Environmental Criteria

- Species Evaluation
  - Are SWFL currently present at the site?
  - Is there existing SWFL habitat on the site?
  - Is there SWFL occurrence data on desired land (occurrence data)?
  - Is there habitat or potential habitat on the property (NNHP SWFL)?
  - Is there habitat or potential habitat on the property (BOR SWFL) (wifl hab distr nad 83)?
  - Is there habitat or potential habitat on the property (NPS SWFL model)?

  - Do other covered riparian birds occur at the site? If yes, complete species evaluation for each covered bird species.

- Proximity to Sensitive Lands
  - Does the desired property abut or is it adjacent to federal, state or conserved lands?
  - Does the desired property abut or is it adjacent to known or potential habitat for SWFL?
- Restoration Potential
  - Are plans in place or easily established for leveraging funds, projects to benefit habitat or species?
  - Does the desired property boundary border the Virgin or Muddy River?
  - Is there standing water at the site?
  - Is there access to water at the site via irrigation district or other means?
  - Does the desired property support native riparian trees or other native riparian wetland plants?
- Level of Disturbance
  - Are noxious weeds (such as tamarisk, tall whitetop) absent that would require treatment?
  - Is minimal restoration needed?
  - Is the desired property absent of infrastructure (such as roads, chemical tanks, out buildings, septic tanks, fences) that may require removal?

Environmental Criteria – Example Value Matrix

property number	A001	A002	A003	A004	A005	A006	
Species Evaluation (2 points for affirmative, 0 points for negative)							
	0	2	0	2	0	0	Are SWFL currently present at the site?
	0	2	0	2	0	0	Is there existing SWFL habitat on the
	0	0	0	2	0	0	Is there SWFL occurrence data on desired land (occurrence data)
	0	0	2	2	0	0	Habitat or potential habitat on the property (NNHP SWFL)
	2	2	2	2	0	0	Habitat or potential habitat on the property (BOR SWFL) (wifl hab distr nad 83)
	2	0	2	2	0	0	Habitat or potential habitat on the property (NPS SWFL model)
	0	0	0	0	0	0	Do other covered riparian birds occur at the site? If yes, complete species evaluation for each covered bird species.
total (14)	4	6	6	12	0	0	
Proximity to Sensitive Lands (1 point for affirmative, 0 for negative)							
	1	1	0	1	1	1	Does the desired property abut or is it adjacent to federal, state or conserved lands?
	1	1	1	1	0	0	Does the desired property abut or is it adjacent to known or potential habitat for S
total (2)	2	2	1	2	1	1	
Restoration Potential (1 point for affirmative, 0 for negative)							
	1	0	0	0	0	0	Are plans in place or easily established for leveraging funds, projects to benefit habitat or species?
	1	1	0	1	0	1	Does the desired property boundary border the Virgin or Muddy River?
	1	1	0	0	0	1	Is there standing water
	1	1	1	1	0	?	Is there access to water at the site via irrigation district
	1	1	1	1	0	0	Does the desired property support native riparian trees or other native riparian wetland plants?
total (5)	4	4	2	3	0	2	
Level of Disturbance (1 point for affirmative, 0 for negative)							
	0	**1**	**1**	**1**	**?**	**0**	Are noxious weeds absent that will require treatment, such as tamarisk, tall whitetop?
	0	**1**	**0**	**0**	**0**	**0**	Is minimal restoration needed?
	1	1	1	1	0	1	Is the desired property absent of infrastructure that may require removal, such as roads, chemical tanks, out buildings, septic tanks, fences?
total (3)	1	3	2	2	0	1	
total	11	15	11	19	1	4	

Environmental Criteria Ranking	
17-24	**priority 1**
9-16	**priority 2**
0-8	**priority 3**

yes 1
no 0

Administrative Criteria – Example Value Matrix

property number	A001	A002	A003	A004	
Ease of Management no (1) yes (0)					
	no	**no**	**no**	**no**	
	1	1	1	1	Are lands difficult to access due to legal issues, safety or other reasons?
	1	1	1	1	Are lands difficult to access due to difficult terrain?
	1	1	0	0	Are there known land use practices, such as grazing, occurring on adjacent land that will negatively affect the habitat or species?
	1	1	1	1	Does the property need a fence to keep out cattle?
	0	0	0	0	Are agreements needed for water with irrigation districts or others?
total (5)	4	4	3	3	
Complexity of Land Acquisition Process no (1) yes (0)					
	no				
	1	1	1	1	Are there existing structures?
	1	1	1	1	Is an environmental assessment likely needed due to underground storage tanks or other reasons?
	1	1	1	0	Will the desired property require further parceling?
	?	?	?	0	Will an additional private survey need to be conducted?
	1	1	1	1	Is the property held in limbo due to the cadastral survey?
total (5)	4	4	4	3	
Potential for Degradation of Habitat if not Purchased for Conservation no (1) yes (0)					
	1	1	0	0	Is habitat in identified flood scour zone?
	0	0	1	1	Is the habitat reasonably protected from degradation from existing or potential future land practices?
total (2)	1	1	1	1	
grand total	**9**	**9**	**8**	**7**	

Administrative Criteria Ranking	
9-12	**priority 1**
5-8	**priority 2**
0-4	**priority 3**

no 1	desirable
yes 0	undesirable

Appendix C

Native Plants in the Riparian Reserves during 2012 and 2013 Surveys

Common Name	Scientific Name	Muddy River Reserve	Virgin River Reserve
Catclaw	*Acacia greggii*	X	
Iodinebush	*Allenrolfea occidentalis*	X	
White bursage	*Ambrosia dumosa*	X	
Fiddleneck	*Amsinckia* sp.	X	
Yerba mansa	*Anemopsis californica*	X	X
Four-wing saltbush	*Atriplex canescens*	X	X
Wheelscale saltbush	*Atriplex elegans*	X	
Desert holly	*Atriplex hymenelytra*	X	
Quailbush	*Atriplex lentiformis*	X	X
Cattle saltbush	*Atriplex polycarpa*	X	
Mulefat	*Baccharis salicifolia*	X	X
Desert brickellbush	*Brickellia desertorum*	X	
Sedge	*Carex* sp.		X
Spiny herb	*Chorizanthe rigida*	X	
Rabbitbrush	*Chrysothamnus nauseosus*	X	
Horseweed	*Conyza canadensis*	X	
Saltgrass	*Distichlis spicata*	X	
Hedgehog cactus	*Echinocereus* sp.	X	
Mormon tea	*Ephedra californica*	X	
Skeleton weed	*Eriogonum deflexum*	X	
Desert trumpet	*Eriogonum inflatum*	X	
Barrel cactus	*Ferocactus cylindraceus*	X	
Singleleaf ash	*Fraxinus velutina*	X	
Snakeweed	*Gutierrezia* sp.	X	
Sunflower	*Helianthus* sp.	X	
Salt heliotrope	*Heliotropium currassavicum*	X	X
White ratany	*Krameria grayi*	X	
Rush	*Juncus* sp.		X
Prickly lettuce	*Lactuca serriola*	X	
Creosote bush	*Larrea tridentata*	X	X
Wolfberry	*Lycium andersonii*	X	X
Pale desert thorn	*Lycium pallidum*	X	
Mojave aster	*Machaeranthera tortifolia*	X	
Common mallow	*Malva neglecta*	X	
Four o'clock	*Mirabilis* sp.	X	
Beavertail cactus	*Opuntia basilaris*	X	
Common reed	*Phragmites australis*	X	
Desert plantain	*Plantago ovate*	X	
James' galleta	*Pleuraphis jamesii*	X	
Saltmarsh fleabane	*Pluchea odorata*		X
Arrowweed	*Pluchea sericea*	X	X
Honey mesquite	*Prosopis glandulosa*	X	X
Screwbean mesquite	*Prosopis pubescens*	X	X
Indigo bush	*Psorothamnus fremontii*	X	
Willow	*Salix* sp.	X	
Coyote willow	*Salix exigua*		X
Goodding's willow	*Salix gooddingii*		X
Desert globemallow	*Sphaeralcea ambigua*	X	
Copper globemallow	*Sphaeralcea angustifolia*	X	
Alkali sacaton grass	*Sporobolus airoides*	X	
Iodine weed	*Suaeda torreyana*	X	
Arrowweed	*Tessaria sericea*	X	
Fiveneedle pricklyleaf	*Thymophylla pentachaeta*	X	
Cattail	*Typha* sp.	X	X

Appendix D

Bird Species Observed during Bird Surveys in 2008, 2009, 2017, and 2018

Avian surveys were conducted at the Muddy River sites 2008 and 2009. Surveys conducted in 2017 and 2018 on included both the Muddy River and Virgin River (Note: if a property was not owned by DCP at the time of survey, it was not included in the survey).

Common Name	Scientific Name	Bunkerville	Mormon Mesa	Riverside	Muddy River
Abert's towhee	*Pipilo aberti*	X	X	X	X
American coot	*Fulica americana*				X
American kestrel	*Falco sparverius*	X			X
American robin	*Turdus migratorius*	X			X
Anna's hummingbird	*Calypte anna*	X			
Ash-throated flycatcher	*Myiarchus cinerascens*	X	X	X	X
Barn swallow	*Hirundo rustica*				X
Bell's vireo	*Vireo bellii arizonae*				X
Bewick's wren	*Thryomanes bewickii*		X		X
Black phoebe	*Sayornis nigricans*			X	X
Black-chinned hummingbird	*Archilochus alexandri*				X
Black-crowned night heron	*Nycticorax*	X			
Black-tailed gnatcatcher	*Polioptila melanura*	X	X	X	X
Black-throated gray warbler	*Setophaga nigrescens*	X			
Black-throated sparrow	*Amphispiza bilineata*			X	X
Blue-gray gnatcatcher	*Polioptila caerulea*				X
Blue-winged teal	*Anas discors*				X
Brewer's sparrow	*Spizella breweri*	X			X
Brown-crested flycatcher	*Myiarchus tyrannulus*		X		
Brown-headed cowbird	*Molothrus ater*	X	X	X	X
Bullock's oriole	*Icterus bullockii*	X			X
Bushtit	*Psaltriparus minimus*	X			X
California gull	*Larus californicus*	X			
Cassin's vireo	*Vireo cassinii*				X
Cedar waxwing	*Bombycilla cedrorum*	X			X
Cliff swallow	*Petrochelidon pyrrhonota*	X		X	X
Common raven	*Corvus corax*	X		X	X
Common yellowthroat	*Geothlypis trichas*	X	X	X	X
Cooper's Hawk	*Accipiter cooperii*	X			
Double-crested cormorant	*Phalacrocorax auritus*	X			
Eurasian collareddove	*Streptopelia decaocto*	X		X	X
Gambel's quail	*Callipepla gambelii*	X		X	X
Great blue heron	*Ardea herodias*	X		X	X

Common Name	Scientific Name	Bunkerville	Mormon Mesa	Riverside	Muddy River
Greater roadrunner	*Geococcyx californianus*	X	X		X
Great-tailed grackle	*Quiscalus mexicanus*	X		X	X
Green Heron	*Butorides virescens*	X			
Hooded oriole	*Icterus cucullatus*				X
House finch	*Haemorhous mexicanus*	X		X	X
House sparrow	*Passer domesticus*	X			X
Indigo bunting	*Passerina cyanea*	X	X	X	X
Killdeer	*Charadrius vociferus*	X		X	
Ladder-backed woodpecker	*Dryobates scalaris*	X	X	X	X
Lark Sparrow	*Chondestes grammacus*			X	
Lazuli bunting	*Passerina amoena*	X			X
Lesser goldfinch	*Spinus psaltria*	X		X	X
Lesser nighthawk	*Chordeiles acutipennis*	X	X	X	X
Lucy's warbler	*Oreothlypis luciae*	X	X	X	X
Mallard	*Anas platyrhynchos*	X		X	X
Marsh wren	*Cistothorus palustris*				X
Mourning dove	*Zenaida macroura*	X	X	X	X
Northern mockingbird	*Mimus polyglottos*	X		X	X
Northern roughwinged swallow	*Stelgidopteryx serripennis*	X	X	X	X
Olive-sided flycatcher	*Contopus cooperi*				X
Orange-crowned warbler	*Vermivora celata*				X
Plumbeous vireo	*Vireo plumbeus*				X
Red-tailed hawk	*Buteo jamaicensis*				X
Red-winged blackbird	*Agelaius phoeniceus*	X		X	X
Ring-necked pheasant	*Phasianus colchicus*				X
Rock wren	*Salpinctes obsoletus*	X		X	X
Ruby-crowned kinglet	*Regulus calendula*				X
Say's phoebe	*Sayornis saya*	X		X	X
Snowy egret	*Egretta thula*	X			
Song sparrow	*Melospiza melodia*	X	X	X	X
Spotted sandpiper	*Actitis macularius*	X			X
Townsend's warbler	*Setophaga townsendi*	X			
Turkey vulture	*Cathartes aura*	X	X	X	X
Verdin	*Auriparus flaviceps*	X	X	X	X
Violet-green swallow	*Tachycineta thalassina*				X
Warbling vireo	*Vireo gilvus*	X			X

Common Name	Scientific Name	Bunkerville	Mormon Mesa	Riverside	Muddy River
Western kingbird	*Tyrannus verticalis*	X		X	X
Western meadowlark	*Sturnella neglecta*	X			X
Western scrub-jay	*Aphelocoma californica*				X
Western tanager	*Piranga ludoviciana*		X		X
Western wood-pewee	*Contopus sordidulus*	X			X
White-crowned sparrow	*Zonotrichia leucophrys*				X
White-winged dove	*Zenaida asiatica*		X		X
Willow flycatcher	*Empidonax traillii*		X		X
Wilson's warbler	*Cardellina pusilla*	X		X	X
Wood duck	*Aix sponsa*				X
Yellow warbler	*Setophaga petechia*	X	X		X
Yellow-breasted chat	*Icteria virens*	X	X	X	X
Yellow-headed blackbird	*Xanthocephalus*	X			X
Yellow-rumped warbler	*Setophaga coronata*	X			X

Appendix E

Permit Request Process

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Requests for Third Party Activities on Reserve Units

While the primary purpose of the Desert Conservation Program (DCP) reserve system properties is to provide mitigation for loss of covered species and their habitat, there are a variety of other allowable activities in the reserve system. The types of allowable uses vary among the reserve system properties as do requirements for formal, written permission for certain activities. In general, activities on DCP reserve properties that disturb the soil outside of open roads and trails, remove rocks, vegetation, seeds or require handling or removal of animals (including insects or spiders) require written permission from the County.

Hunting: Hunting is allowed in the Boulder City Conservation Easement where allowable by state law and local ordinances. The DCP does not process hunting requests but defers to Nevada Department of Wildlife permits, rules, and regulations. Hunting is not an allowable activity in any other reserve property.

Request requirements

All requests must be made in writing or by email. Minimum request details include:

- Requestor name and contact info,
- Location of the activity,
- Date of the activity (range of dates is OK),
- Description and purpose of the activity,
- Description of any ground or species disturbance, and
- Description of collection of plant/animal/mineral or other materials.

Please complete and submit the attached form to DCP@ClarkCountyNV.gov but do not sign it. A signature will be requested from the applying party upon approval and will acknowledge any terms and conditions set forth by the DCP.

Notification

Approval or rejection of each request, along with any conditions on the request, will be provided to the requestor by email. Approval of a request will contain a signed copy of the following form and any terms and conditions set forth by the DCP. The actions requested are not completely approved until the requestor returns a copy of the form with their signature and date acknowledging acceptance of the Reserve Use Permission terms and conditions. Rejected applications will receive an email with a brief explanation as to why the application was rejected.

Request for Third Party Activities on the Reserve Units

Clark County Desert Conservation Program
4701 W Russell Rd, Suite 200
Las Vegas, NV 89118

dcp@ClarkCountyNV.gov
Phone (702)455-3536

Requestor's name, email, phone number(s) and mailing address:
Permission is sought for the undersigned to conduct the following activities. Requestor may also attach a summary or complete methods description. Activities:
Dates Requested:
Name of Desert Conservation Program Reserve:

This permission is not valid until a countersigned and dated copy of this form is received from the Clark County Desert Conservation Program. The undersigned shall indemnify, defend and hold harmless Clark County, Nevada and its officers, agents, and employees against any and all damages, claims, or causes of action arising from or in connection with the activities described on this form. The undersigned is responsible for compliance with all federal, state, and local laws, rules, and regulations and any terms and conditions attached to this Reserve Use Permission. A copy of the final form, including terms and conditions, must be with the undersigned at all times while conducting these activities on the reserve property.

Requestor's Signature Date

Department of Environment and Sustainability Director or Assistant Director Signature Date

Appendix F

Contact Information for Management, Safety, and Services

Contacts

Property Management, Safety, and Services

Agency	Phone Number	Purpose
Desert Conservation Program	702-455-3536	Property Management
Clark County Fire Department	911	Fire – Emergency
		Medical – Emergency
Las Vegas Metropolitan Police Department	911	Law Enforcement – Emergency
	311	Law Enforcement – Non-emergency
Nevada Highway Patrol	911	Traffic – Emergency
	702-486-4100	Southern Command
	702-864-2323	Southern Command – Moapa Substation
Bureau of Land Management	702-631-2350	Wildland Fire – Emergency
	702-515-5300	Interagency Communications Center – Non-emergency
	702-293-8932	Law Enforcement – Emergency
	702-293-8998	Law Enforcement – Non-emergency
Moapa Valley Water District	702-397-6893	Municipal Water Connection
Overton Power District	702-397-2512	Electrical Service Connection
	888-409-6735	Electrical Service Connection – Emergency

Appendix H

Climate Change Worksheets

Worksheet 1: Sensitivity and adaptive capacity of species, habitats, and mitigation measures. The goal is to focus on aspects of climate change that matter for your HCP, not just the changes most commonly discussed; and to think about how easy it is for species, habitats, and mitigation measures to adapt/be adjusted over the near and long term.

Worksheet 1b, MITIGATION MEASURES: Sensitivity and adaptive capacity of mitigation measures.						
Species	Mitigation Measure	What climate- related factors matter for this mitigation measure?	What could happen in response to changes (think re. thresholds and gradual changes)?	How easily could the management measure adjust/be adjusted to changes in the near term? What would it take?	How easily could the management measure adjust/be adjusted to changes in the long term?	How could changes in covered species influence effectiveness?
All Plants	Monitoring - Rare Plant Surveys (to establish baseline conditions and performance monitoring)	Precip patterns, temperature (Germination/bloom timing, abundance)	Increasing unpredicatability in bloom timing and abundance may make rare plant survey timing difficult and may lead to false negatives, and extended drought could also lead to inability to detect annual species.	It would be fairly easy to require more surveys or adjust timing (i.e. quarterly or precip timed surveys). Although timing in extended drought years will be difficult and may need to conisder not surveying in those years or reduced efforts.	Same.	Psammophiles and blackbrush associated species may require adjustments due to shifts in range, requiring expanded surveys that would include new areas of potential habitat. Range shifts could be outside of managed lands and the Plan Area.
Mojave poppy bee	Monitoring - Adult bee surveys (to establish baseline conditions for performance monitoring)	Precipitation patterns, soil temperature, timing of host plant bloom	Unpredictable precipitation patterns and/or increases in average temperatures could affect soil temperatures and soil moisture availability, affecting host plant germination and bloom time, and ultimately the timing of adult MPB emergence. These changes are presumed to be gradual; however, it is unknown if there are thresholds such as temperatures or moisture levels which could limit effective reproductive cycle of MPB.	It would be fairly easy to require more surveys or adjust timing surveys based on the advice of experts and survey data.	Same.	Increasing unpredicatability in timing of adult emergence may make survey timing difficult and lead to false negatives
Joshua Tree	Monitoring - Vegetation Mapping	Precip patterns, temperature may affect germination, bloom time	range shift (gradual), mismatch with pollinators (if pollinators also don't shift timing with bloom changes) would be gradual and species is long-lived; potential for germination success to have threshold that temp, precip, or soil conditions could result in no success	Boundaries of mapped habitat may need to be adjusted if species shifts outside of reserve areas or restricted area of recruitment within the reserve system noted.	Same.	Range shifts may take species outside of reserve areas and/or the Plan Area
Perennial plant species	Transplant to reestablish after temporary disturbance or to establish the species in new areas; transplanting with genetic diversity maintenance planning incorporated.	Temperature, precip, erosional/depositional events (related to heavy precip)	Changes in average temperature as well as erosional events related to heavy precipitation may alter suitable habitat (for example, could damage the cryptogamic crust) and success of salvage/transplants	Maintenance post-transplant to increase survival (watering, shading until established if climate changes reduce success without this management), adjustments should not be difficult unless soil damage is preventing success	It would be significantly more challenging to determine the longterm suitability of habitat where the transplanting would occur. Long term population trend monitoring and long term experimental establishment could aid in predicting long term habitat suitability. If thresholds are reached making habitat unsuitable (water availability, temperature max), and new habitat is not identified (potential extablishment in new areas limited), this measure may not be successful in long-term.	Habitat suitabilty at existing and potential sites may fluctuate. More active management may be necessary to manage species survival through fluctuations. Decreases in genetic diversity resulting from the salvage process may result in less adaptability when establishing or reestablishing populations.

Species	Mitigation Measure	What climate- related factors matter for this mitigation measure?	What could happen in response to changes (think re. thresholds and gradual changes)?	How easily could the management measure adjust/be adjusted to changes in the near term? What would it take?	How easily could the management measure adjust/be adjusted to changes in the long term?	How could changes in covered species influence effectiveness?
Annual plant Species	Seed collection/seeding with genetic diversity maintenance planning incorporated. Seed collection/salvage may include collection of soil inoculum in areas such as cryptogamic crusts for reseeding.	Temperature, precip, erosion/depositional events (related to heavy precip)	Habitat suitabilty at existing and potential sites may fluctuate or may reduce success of seeded plants. If seed collection efforts are not conducted in multiple years with varying precipitation patterns, it is plausible that seeds with unique phenotypes may not be collected, resulting in a decrease in genetic diversity.	Potentially adjust seed collection protocol to include at least on normal water year and one water year that is not normal to collect range of diversity/variety of species. In situ pollination could be used when bulking collected seed material. Maintenance of seeded plants to increase survival (watering, shading until established if climate changes reduce success without this management), adjustments should not be difficult unless soil damage is preventing success.	It would be significantly more challenging to determine the longterm suitability of habitat where the seeding would occur. Long term population trend monitoring and long term experimental establishment could aid in predicting long term habitat suitability. If thresholds are reached making habitat unsuitable (water availability, temperature max), and new habitat is not identified (potential establishment in new areas limited), this measure may not be successful in long-term.	Lower genetic diversity resulting from range constriction and/or decreased reproduction could decrease long-term adaptability of salvaged populations. More active management may be necessary to manage species survival through fluctuations in habitat suitability.
All plants, Mojave poppy bee	post-fire restoration response program	Increased fire return interval, shifts in seasonal weather resulting in an increased non-native invasive plant presence	Threshold for recovery could be surpassed if fire return interval too short. Establishment of non-natives post-fire may be quick and not gradual; fire temperature may also impact seed bank and be threshold for post-fire recovery.	It is reasonable to forsee such a program being able to adapt to near term changes in climate. Such changes could include whether or not a specific restoration area receives passive or active restoration treatments. Additionally, it is reasonable to believe that such a program could conduct regular reviews of program efficacy and if more active post-fire management is necessary and feasible	If fire frequency increases above a certain level, management of nonnative plants and post-fire recovery may not be manageable in the long-term. habitat conditions outside of the reserve may make management of the reserve areas difficult. Focus may need to shift to target areas within reserve systems and this may depend on range shifts of species that are being managed.	Covered species could be introduced into areas with suitable habitat through restoration. And species range may shift
All plants, Mojave poppy bee	fencing- grazing/public access exclusion	Increased fire return interval could result in more frequent damage to fences	if range shifts are observed, may need to move fence based on suitable habitat for plants; fence inspections and repairs may become more common with increased fire/fire damage	The type of fence will determine how easy it is to move or repair (likely to be easy to move). Change of fence repair monitoring program fairly easy to adjust	Same.	For gypsophile group- wouldn't see much change in species range. For other species (e.g. Joshua tree) where may be shifts, fence may decrease in effectiveness if species range shifts outside of fenced boundaries

Species	Mitigation Measure	What climate- related factors matter for this mitigation measure?	What could happen in response to changes (think re. thresholds and gradual changes)?	How easily could the management measure adjust/be adjusted to changes in the near term? What would it take?	How easily could the management measure adjust/be adjusted to changes in the long term?	How could changes in covered species influence effectiveness?
All plants	weed and fuel management (targeted herbicide, mechanical, hand removal)	increase average temperature, increase peak temperatures, changes precipitation pattern, increasing fire return interval	As invasive species populations grow in expanse due to climate change, they will invade areas with sensitive resources, necessitating increased levels of management effort. In addition, new invasive species may become more dominate due to shifts in habitat conditions. Increases in temperature and changes in precipitation may promote invasive weed growth and potential for fire frequency, which would increase the frequency and expand areas in which management is necessary. There may be a decrease in the number of days where chemical treatment is feasible due to shifting weather patterns.	As invasive species become more prevalent in areas with sensitive species, the amount of effort needed to manage these areas will increase. This is theoretically an easy change and can be adapted to changes in timing for management actinos can be shifted based on plant growth patterns or growing periods (rainfall patter changes may increase growing period and require multiple management efforts).	The amount of effort needed to manage these areas will increase and management may be difficult in the long term. In addition, as new invasive species arrive, novel control methods may need to be developed. Also, novel control methods may need to be developed in response to developed resistence to specific chemicals. As weather patterns change, the logisitcs of chemical treatments may become increasingly difficult. habitat conditions and weed sources outside of the reserve system may make management of the reserve areas difficult. Focus may need to shift to target areas within reserve systems and this may depend on range shifts of species that are being managed.	If range shifts occur, management areas may need to be refocused and competition between non-natives and natives may need to be more finely managed if non-natives encroach on covered species habitat. temperature and moisture/water availability may also make covered species more sensitive to management disturbances. If non-native plant growth overlaps with covered speceis, certain management methods may need to be adjusted.
Annual plant Species - priority sticky buckwheat and threecorner milkvetch, potentially alkali mariposa lily outside of reserve system	Seasonal Area Use Restrictions (growth and blooming period)	Shifting precip patterns, increased average temperatures, increased extreme temperatures, decreased fire return intervals, increased exotic plant species presence	If population numbers are below a specific amount for a certain number of consecutive years, seasonal area use restriction could be imposed or made more strict.	This management measure is highly adaptable. Restrictions can be put into place at any point in time, and focus on sensitive growth or pollination periods as determined from research.	This measure is highly adaptable. If soil or other abiotic conditions change such that habitat conditions are not suitable, this measure may not be effective in the long term. If use restrictions were to be applied for too many consecutive years, there may be a conflict between conservation needs and BLM management goals.	If populations become extirpated from an area, use restrictions would not be enough on its own to recover populations.
three-corner milkvetch, alkali mariposa lilly, Pahrump Valley buckwheat, sticky buckwheat, white-margined beardtongue, Parish's phacelia, St. George's blue-eyed grass, Las Vegas bearpoppy, sticky ringstem, Las Vegas buckwheat, silverleaf sunray	Designated OHV Recreation Areas	Shifting precip patterns, increased average temperatures, increased extreme temperatures, decreased fire return intervals, increased exotic plant species presence	If sensitive species negatively respond to changes in climate, certain populations may become more critical for species conservation. (i.e. as some populations shrink, other relatively larger populations will become more critical to conserve as a source of genetic diversity); species sensitivity to soil disturbance may increase as individuals are stressed from other extreme conditions (temperature and moisture changes)	if covered species range shifts, and OHV areas are in new suitable habitat, it would be difficult to change designation of areas. Review OHV areas every 10 years to determine if relocation of OHV area necessary for species protection.	Same.	Populations could become established near designated OHV areas. Also, Designated OHV areas could become highly suitable habitat for sensitive species.

Species	Mitigation Measure	What climate- related factors matter for this mitigation measure?	What could happen in response to changes (think re. thresholds and gradual changes)?	How easily could the management measure adjust/be adjusted to changes in the near term? What would it take?	How easily could the management measure adjust/be adjusted to changes in the long term?	How could changes in covered species influence effectiveness?
three-corner milkvetch, sticky buckwheat and potentially Pahrump Valley buckwheat, white-margined beardtongue	Sand Source Area Preservation	Shifting precip patterns, decreased fire return intervals, increased exotic plant species presence	precipitation and temperature changes may change soil source and erosion patterns. This would probably be a gradual change as conditions shift, potential shift in location of sand depostion	This may be difficult to manage if weather patterns shift deposition areas or erosion patterns.	Same.	range shifts could adjust where suitable habitat is located based on weather conditions, but this may not align with suitable soil. this could reduce suitable habitat locations.
Desert tortoise, banded gila monster, desert pocket mouse	Conserve habitat linkages between reserve lands when feasible	increased average temperatures, increased peak temperatures, precipitation changes, vegetation community conversion	Linkage habitats that are suitable today may degrade to the point where they are no longer usable by species for dispersal. This would be a gradual change.	May be difficult and could require more land acquisition-If land is available, buffers could be created along linkages to ensure heterogeneity of habitats within linkages, provide suitable refugia, etc. Fencing/walls could be installed to direct terrestrial species away from unsuitable habitats.	As development encroaches upon linkages, acquisition of land for buffers may not be affordable or even possible. Or as habitat changes, land may become unsuitable and unable to be managed to maintain habitat for species corridors.	Species may not be able to disperse quickly enough through linkages as vegetation communities change to connect to other current or future suitable habitats. Changes in fitness of individuals may limit migration distance and success.
Desert tortoise, banded gila monster, desert pocket mouse	RRTH (Reintroduction, relocation, translocation, headstarting) --- assisted migration into currently suitable unoccupied areas or unoccupied but predicted to be suitable habitats.	increased average temperatures, increased peak temperatures, precipitation changes, vegetation community shift; precipitation levels	Species may not tolerate high temperatures; decreased precipitation/prolonged drought may lead to limited food supply; change in habitat is likely to be gradual but threshold may be reached especially for gila monster in relation to summer water availability. RRTH would be implemented if habitat becomes suitable in areas that natural colonization is difficult (barriers to dispersal, distance, etc) and this method determiend to be beneficial to establish species in these habitats.	RRTH is mostly unproven for most species, but as habitat shifts this could be implemented to assist migration to newly suitable habitat. Some success with tortoise RRTH. Success or failure is hard to determine short-term. New habitat may prove unsuitable from other unknown factors or be negatively affected by prolonged drought.	Implementation of RRTH can be based on monitoring of habitat conditions and documentation of shifts in suitability. Long term studies may be able to refine methodologies and habitat modeling to make RRTH more successful. Success or failure of RRTH may be more apparent over long term.	Response to RRTH may depend on fitness of individuals/ability of species to adapt to new locations.
Desert tortoise, banded gila monster, desert pocket mouse, burrowing owl	Microhabitat management (artificial burrows, management of fossorial mammals)	Increased temperatures and changes in precipitation may impact fossorial mammal populations and desert tortoise populations, reducing available burrows for BUOW and refugia for other covered species. Increased temps could necessitate deeper burrows, i.e. older abandoned burrows typically used may no longer be sufficient/suitable condtions. Potential to impact reproductive output and sex ratio of DT	Species would have fewer refugia or burrows, may seek out habitat elsewhere that may be lower quality. If conditions change sufficiently, then burrows may not provide suitable habitat. Likely to be a gradual change, but eventually reach a threshold where burrows don't maintain suitable temperatures/refugia.	Implementation of artificial burrows should not be difficult provided all other habitat components are in place (adequate food, cover, vegetation). Success may be hard to gauge in the short term (15-20 years). Habitat monitoring would be utilized to provide data on when artificial burrows may be recommended for installation.	Same.	Some species may be more adaptible or mobile; others may have limited ability to migrate to new, more suitable areas. artificial burrow parameters/design may not be well-studied for all covered species and additional research needed to ensure proper design.

Species	Mitigation Measure	What climate- related factors matter for this mitigation measure?	What could happen in response to changes (think re. thresholds and gradual changes)?	How easily could the management measure adjust/be adjusted to changes in the near term? What would it take?	How easily could the management measure adjust/be adjusted to changes in the long term?	How could changes in covered species influence effectiveness?
Yellow-bileld cuckoo, Arizona Bell's vireo, southwestern willow flycatcher, Ridgway's rail, desert pocket mouse	Management of hydroperiod or moisture regimes (irrigation, site excavation, vegetation management, riparian buffer creation, down wood recruitment, litter supplementation)	increased average temperatures, increased peak temperatures, precipitation changes, vegetation community conversion, decreased insect prey base	Decreased precipitation, decreased groundwater levels due to decreased precipitation and increased extraction, all resulting in changes to habitat (plant species/structure, die off of large trees, increases in invasive plants). Assume changes and response would be gradual, but could manage at threshold level (water level managed to maintain a minimum depth)	Some measures would be easier to be adjusted but all would have to be coordinated in order to produce the desired results. Riparian vegetation can be established in a relatively short period of time. Water availability/water rights may limit ability to manage hydroperiod/moisture in some locations. Create thermal refugia for species.	Long-term adjustments would be more difficult to plan for as some aspects are unpredictable (e.g., precipitation changes) or require buying water rights (if possible)	Even with adequate management of water and riparian vegetation, species may not be able to adapt to higher temperatures or other habitat changes. For migratory species, habitats and conditions outside of County may influence species status and be outside of County control.
Golden eagle, burrowing owl, loggerhead shrike	Prey management: Coordinate with NDOW to limit public hunting for certain prey (e.g., rabbits, small mammals) in sensitive areas, limit use of rodenticides in reserve system and where feasible restrict use through County use permits for covered activity approval in sensitive areas	Prey may be similarly affected by climate change as these species - impacted by temperatures, precipitation, vegetation shifts	Collapse of prey populations, shifts in prey type availability.	Some measures (e.g., rabbit hunting, ground squirrel control, rodenticide use near reserve lands) could be changed through regulations.	Same. If prey populations shift with climate as well, then regulatory management may not be effective in the long-term	Limits to temperature tolerance more likely to be a factor for diurnal species such as golden eagle.
burrowing owl, Townsend's big-eared bat, spotted bat	Prey management: In reserve system and where feasible in County use permits for covered activity approval, limit pesticide use to maintain invertebrate population	Prey may be similarly affected by climate change as these species - impacted by temperatures, precipitation, vegetation shifts	Collapse of prey populations, shifts in prey type availability.	Pesticide use restrictions near reserve lands could be changed fairly easily through regulations. Or implement use of established/researched bio control for invertebrate pests if additional control required	Same. If prey populations shift with climate as well, then regulatory management may not be effective in the long-term	Limits to water availability may be a separate major factor for bat species
All wildlife	Habitat management (invasive species control, fire control, restoration, travel and transportation planning [e.g. closing roads])	increased average temperatures, increased peak temperatures, precipitation changes, vegetation conversion/shift, fire frequency changes	Restoration may not be effective over the long term as vegetation communities shift. Some species (e.g., sagebrush, shadscale) may not return from seed after fire in heavy annual grass cover.	Easily for some measures (invasive control, fire control, controlled burns, restoration of riparian habitats). Thresholds for recovery post-fire or other events could be reached if multiple fires occur in close succession or fire temperature too hot and burns seed bank. Restoration in desert ecosystems may be slow due to climatic conditions and overall slow growth and recovery of arid habitats.	Management may need to shift frequency of some actions (invasive control which will also hep reduce fire risk) or switch to reseeding/planting to help areas recover. In the long-term if habitat shifts from temperature/water availability, active management in the same location may not be successful and review of suitable habitat locations/shifts	Remnant populations may not be viable in the long term dependent upon species; range shifts outside of the managed habitats; climatic thresholds surpassed for species in managegd habitats (external factors that cannot be controlled such as daytime temperature max)

Worksheet 1: Sensitivity and adaptive capacity of species, habitats, and mitigation measures. The goal is to focus on aspects of climate change that matter for your HCP, not just the changes most commonly discussed; and to think about how easy it is for species, habitats, and mitigation measures to adapt/be adjusted over the near and long term.

Worksheet 1c, HABITATS: Sensitivity and adaptive capacity of habitats

Habitat	What climate-related factors matter for this habitat?	What could happen in response to changes (think re. thresholds and gradual changes)?	How easily could the habitat adjust to changes in the near term? What would it take?	How easily could the habitat adjust/be adjusted to changes in the long term?	How could covered activities affect the exposure, sensitivity or adaptive capacity of habitat?
Blackbrush	extreme temperature peaks leading to increased fire frequency	positive feedback loop between fire frequency and establishment and spread of invasive species	Habitat may not adjust easily as this landscape does not have a frequent fire regime and fire generally not natural in blackbrush, and non-native, invasive plants readily establish post-fire without intervention by management. To assist with fire resilience, a more aggressive and proactive fire and fuel management approaches and invasive weed control may be necessary. Proactive prevention of weed invasions into the County would help to ameliorate feedback loop between fire frequency and invasive species spread. Also likely need to do active replanting and maintenance because natural reestablishment/recovery could take centuries.	Same.	development of infrastructure, recreation, agriculture, or urban development may facilitate the spread of invasive species, increasing fire risk; these factors may result in increased ignition sources (chain sparks, prescribed burns, campfires, lit cigarettes, etc.)
Blackbrush	increased annual temperatures	suitable habitat for this ecosystem type and/or species within this ecosystem type may change	Elevational shifts in ecosystem type (and species) ranges could occur naturally with increased annual temperatures and may shift upslope/higher elevation. If this does occur, this is likely a gradual encroachment/shift on adjacent ecosystems. However, dependent upon how quickly climate changes, may require augmentation or facilitation (transplantation, etc.) for long-lived or slow-reproducing species.	Same, but as changes accumulate the adaptive capacity of the ecosystem type and species' ranges may decrease as distance from historic ranges increase	Ecosystem type conversion leading to loss of genetic diversity (esp for dominant plant species and their pollinators, and keystone species) could limit adaptive capacity ; ecosystem type conversion or habitat conversion adjacent to ecosystem type could limit potential range expansion/shift. Habitat fragmentation could lead to increased edge effects and decreased fitness and dispersal ability, resulting in decreased adaptive capacity

Habitat	What climate-related factors matter for this habitat?	What could happen in response to changes (think re. thresholds and gradual changes)?	How easily could the habitat adjust to changes in the near term? What would it take?	How easily could the habitat adjust/be adjusted to changes in the long term?	How could covered activities affect the exposure, sensitivity or adaptive capacity of habitat?
Desert Riparian	extreme temperature peaks leading to increased fire frequency, increased rate of soil evaporation	positive feedback loop between fire frequency and establishment and spread of invasive species. Increased temperatures could also increase soil moisture evaporation in this habitat. This decreased soil moisture could negatively impact some invertebrate populations and food sources for riparian bird species. Establishment of invasive plant species could compound the soil moisture impacts as many invasives have high water consumption which can lower the water table/water availablity.	Habitat may not adjust easily as this landscape does not have a frequent fire regime, and non-native, invasive plants readily establish post-fire without intervention by management. Presence of water in these systems may help resilience post-fire, but a more aggressive and proactive fire and fuel management approaches and invasive weed control may be necessary. Aggressive treatment of weeds (especially tamarisk) would be needed following fire to ensure revegetation by riparian species	Same.	development of infrastructure, recreation, agriculture, or urban development may facilitate the spread of invasive species, increasing fire risk; these factors may result in increased ignition sources (chain sparks, prescribed burns, campfires, lit cigarettes, etc.). Development activities affecting the course of surface water hydrology or ground water table drawdown could also affect ability of riparian vegetation to re-establish post-fire
Desert Riparian	Changes in precipitation patterns	Altered precipitation regimes could result in erosional events or insufficient water, which could alter the range and/or amount of suitable habitat for this ecosystem type. Heavy rains could wash away leaf litter, increasing evaporation rates and decreasing localized humidity levels. more consistent stress (drought and flood events more constant) could reduce survival or reproductive capacity/success of plants/animals in ecosystem	Ecosystem type may not adjust quickly on its own as it is a water dependent ecosystem. Ability of plants to deepen roots to reach groundwater may impact ability to adapt. Management may need to monitor groundwater levels and place groundwater pumping restrictions to limit groundwater drawdown or other activities to assist in ecosystem adaptation.	Same	Development activities affecting the course of surface water hydrology or ground water table drawdown could also affect the amount and location of suitable habitat for this ecosystem type and how quickly water levels change in the ecosystem
Mesquite Acacia	extreme temperature peaks leading to increased fire frequency	positive feedback loop between fire frequency and establishment and spread of invasive species.	Habitat may not adjust easily as this landscape does not have a frequent fire regime, and non-native, invasive plants readily establish post-fire without intervention by management. Presence of water in these systems may help resilience post-fire, but a more aggressive and proactive fire and fuel management approaches and invasive weed control may be necessary. Aggressive treatment of weeds (especially tamarisk) would be needed following fire to ensure revegetation by shrub and ecosystem-associated species	Same.	development of infrastructure, recreation, agriculture, or urban development may facilitate the spread of invasive species, increasing fire risk; these factors may result in increased ignition sources (chain sparks, prescribed burns, campfires, lit cigarettes, etc.). Development activities affecting the course of surface water hydrology or ground water table drawdown could also affect ability of desert wash/ecosystem-associated species to re-establish post-fire

Habitat	What climate-related factors matter for this habitat?	What could happen in response to changes (think re. thresholds and gradual changes)?	How easily could the habitat adjust to changes in the near term? What would it take?	How easily could the habitat adjust/be adjusted to changes in the long term?	How could covered activities affect the exposure, sensitivity or adaptive capacity of habitat?
Mesquite Acacia	Changes in precipitation patterns, lowering of water table	Altered precipitation regimes could result in erosional events or insufficient water, which could alter the range and/or amount of suitable habitat for this ecosystem type. Heavy rains could wash away leaf litter, increasing evaporation rates and decreasing localized humidity levels	Ecosystem type may not be adjust on its own as it is a water-dependent ecosystem. if conditions change gradually, maybe plant species can deepen roots to reach groundwater, but this is unknown response overall, and if change happens too quickly reaction may appear more like a threshold with quick drop in groundwater levels and inability of many plants to survive.	Same	Development activities affecting the course of surface water hydrology or ground water table drawdown could also affect the amount and location of suitable habitat for this ecosystem type
Mojave Desert Scrub	extreme temperature peaks leading to increased fire frequency	positive feedback loop between fire frequency and establishment and spread of invasive species	Habitat may not adjust easily as this landscape does not have a frequent fire regime, and non-native, invasive plants readily establish post-fire without intervention by management. Proactive prevention of weed invasions into the County would help to ameliorate feedback loop between fire frequency and invasive species spread	Same.	development of infrastructure, recreation, agriculture, or urban development may facilitate the spread of invasive species, increasing fire risk; these factors may result in increased ignition sources (chain sparks, prescribed burns, campfires, lit cigarettes, etc.)
Mojave Desert Scrub	increased annual temperatures	suitable habitat for this ecosystem type and/or species within this ecosystem type may change	Elevational shifts in ecosystem type (and species) ranges could occur naturally to accommodate increased annual temperatures, but may require augmentation or facilitation (transplantation, etc.) and management areas and techniques may need to be modified accordingly.	Same, but as changes accumulate the adaptive capacity of the ecosystem type and species' ranges would decrease as distance from historic ranges increase	Ecosystem type conversion leading to loss of genetic diversity could limit adaptive capacity; ecosystem type conversion or habitat conversion adjacent to ecosystem type could limit potential range expansion/shift; heat island effect from solar enery farms and urban development may increase local temperatures in habitat; Habitat fragmentation could lead to increased edge effects in habitat
Mojave Desert Scrub	increased rate of soil evaporation	salt crust or higher surface soil salinity levels	Habitat would be unlikely adjust- may result in conversion to Playa or Salt Desert Scrub	Same	Activities that result in groundwater drawdown may lead to increased rate of soil evaporation; may be harder to re-establish revegetation after temporary vegetation removal or disturbance depending on the amount of time elapsed before revegetation
Mojave Desert Scrub - gypsum soil substrate	N/A	N/A - the distribution of gypsum soils is unlikely to change in response to climate change	N/A- changes to substrate are not expected as a result of climate change	Same.	although climate may have less of an effect on this habitat type, disturbance to the soils can damage or degrade the habitat. Disturbance from covered activities such as development, OHV, roads and infrastructure can degrade this habitat.

Habitat	What climate-related factors matter for this habitat?	What could happen in response to changes (think re. thresholds and gradual changes)?	How easily could the habitat adjust to changes in the near term? What would it take?	How easily could the habitat adjust/be adjusted to changes in the long term?	How could covered activities affect the exposure, sensitivity or adaptive capacity of habitat?
Mojave Desert Scrub - crypogamic crust	precipitation extremes, temperature increase	Heavy precipitation could temporarily damage cryptogamic crusts; fires resulting from increased temperatures/temperature spikes can also temporarily damage cryptogamic crust; if event is large enough these could be threshold events to change habitat	In the absence of a catastrophic event, cryptogamic crusts should re-establish within two decades. There is some data and research on this potential, but may need to fund research specific to local soils. Management could assist in prevention of threshold events - fuel modification and fire management to reduce fire frequency/intensity	Same. Research being done on reestablishing, in the future there might be efforts to assist in the long term such as inoculation	Damage from covered activities to cryptogamic crust would limit adaptive capacity. Disturbance from covered activities such as development, OHV, roads and infrastructure can degrade this habitat.
Salt Desert Scrub	extreme temperature peaks leading to increased fire frequency	positive feedback loop between fire frequency and establishment and spread of invasive species	Habitat may not adjust easily as this landscape does not have a frequent fire regime, and non-native, invasive plants readily establish post-fire without intervention by management. To assist with fire resilience, a more aggressive and proactive fire and fuel management approaches and invasive weed control may be necessary. Proactive prevention of weed invasions into the County would help to ameliorate feedback loop between fire frequency and invasive species spread.	Same.	development of infrastructure, recreation, agriculture, or urban development may facilitate the spread of invasive species, increasing fire risk; these factors may result in increased ignition sources (chain sparks, prescribed burns, campfires, lit cigarettes, etc.)
Salt Desert Scrub	increased annual temperatures	location of this ecosystem type may change if annual temperatures increase	Elevational shifts in ecosystem type (and species) ranges could occur naturally to accommodate increased annual temperatures if change is gradual, but may require augmentation or facilitation (transplantation, etc.) if change occurs to quickly for species/habitat to adjust and management may need to be incorporated	Same, but as changes accumulate the adaptive capacity of the ecosystem type and species' ranges would decrease as distance from historic ranges increase	Ecosystem type conversion leading to loss of genetic diversity could limit adaptive capacity; ecosystem type conversion or habitat conversion adjacent to ecosystem type could limit potential range expansion/shift; heat island effect from solar enery farms and urban development may increase local temperatures in habitat
Salt Desert Scrub	increased rate of soil evaporation	salt crust or higher surface soil salinity levels; soil salinity could increase which could result in some cementation, but in time frame of MSHCP caliche unlikely to form	Habitat would be unlikely adjust- may result in conversion to Playa or salt flat	Same	Activities that result in groundwater drawdown may lead to increased rate of soil evaporation; may be harder to re-establish revegetation after temporary vegetation removal or disturbance depending on the amount of time elapsed before revegetation
Playa	increased rate of soil evaporation	salt crust or higher surface soil salinity levels; formation of caliche may lead to restrictive layer in soil subsurface	Habitat would be unlikely adjust- may erode or covert to Salt Desert Scrub	Same	Activities that result in groundwater drawdown may lead to increased rate of soil evaporation; may be harder to re-establish revegetation after temporary vegetation removal or disturbance depending on the amount of time elapsed before revegetation

Worksheet 2: Exposure: Climatic changes and ecological implications. Think about what various climate-related changes might mean for the species, ecosystems and processes within the HCP area; for human actions (important for cumulative impacts assessment); at the landscape level (e.g. hydrologic processes), and what all of this could mean for particular HCP sections, decisions, or analyses. Consider filling out multiple worksheets as needed for the various species, systems, scales, and processes of interest.

Climatic changes and effects	**Ecological implications**			
	Potential HCP-relevant effects on *natural systems* (species, habitats, biotic interactions)?	Potential HCP-relevant effects on *human systems* (behavior, economics, policy)?	Possible *landscape* scale effects that could affect species/systems within the HCP area?	*HCP sections (chapters)* that could be influenced by any of the changes or effects? How?
Longer, more frequent, more intense droughts (driven by groundwater availability)	Lowering water table- Spring-dependent species/desert riparian habitat may experience significant water stress during droughts. Impacts to long-term survivability. Decreased Habitat/prey availability and habitat suitability (e.g. humidity levels) for riparian bird species? Decreased canopy coverage. Synergistic effect between establishment of tamarisk and decreases in groundwater availability	increased groundwater pumping (agricultural, urban)- if water use increases, can further lower water table and increase intensity and duration of drought (ground water availability). Agricultural systems may need to be converted based on groundwater availability. Limits on development if less groundwater is available	Conversion of riparian habitat- Muddy River is spring-fed; lowering of groundwater table may affect downstream riparian habitat/water surface flows. Ground subsidence- result in soil disturbance/soil crusts. Opportunity for invasive plant invasion?	Conservation Strategy- Adaptive management plan, mitigation/minimization measures, reserve system (large enough to cover changes), BGOs; Changed circumstances; Covered Activities - agriculture and development; Covered Species- range shifts and species distributions; Permit Duration- 50 years permit term may actually see these changes during term, take predictability/estimations
Longer, more frequent, more intense droughts (driven by surface water flows)	Decreased Habitat/prey availability and habitat suitability (e.g. humidity levels) for riparian bird species; Decreased canopy coverage as water-dependent species die from stress; Decreased access to drinking water (reptiles) and increased physiological stress; groundwater recharge and soil moisture content reduced from less surface water; shoreline level fluctuations (plant and riparian bird species)	Increased groundwater pumping (agricultural, urban)- if water use increases, can further lower water table and increase intensity and duration of drought (ground water availability linked to surface water availability). Agricultural systems may need to be converted based on water availability; increased cost of development as water becomes scarce; limits on development if less water is available (not enough drinking water availability)	Conversion of habitat (riparian, desert washes); species distributions changing to where water/prey is located; facilitation of non-native species establishment; increased evaporation/soil moisture content loss leading to increase soil salinity	Conservation Strategy- Adaptive management plan, mitigation/minimization measures, reserve system (large enough to cover changes), BGOs; Changed circumstances; Covered Activities - agriculture and development; Covered Species- range shifts and species distributions; Permit Duration- 50 years permit term may actually see these changes during term, take predictability/estimations
More extreme temperature peaks	increased physiological stress, reduced activity periods (avoiding extreme temps), increased susceptibility to dessication (plants), decreased reproductive success	increased energy use (for cooling systems), more development of energy infrastructure to support energy use long-term; more nighttime activities (increased artificial night lighting)	increased fire risk on extreme temp days	Covered species, BGOs, AMM, Changed circumstances, Adaptive management, covered activities, take predictability/estimations
More frequent, intense, and longer heat waves	increased physiological stress and potential mortality, lower water turgor, stunted growth, susceptibility to dessication (plants); reduced activity periods (avoiding extreme temps) leading decreased health or mortality (animals); decreased reproductive success (also changes to sex ratio for tortoise); susceptibilty to disease	increased energy use (for cooling systems) and costs - potential time of use charge systems, more development of energy infrastructure to support energy use long-term; more nighttime activities (increased artificial night lighting), reduced development (emigratingand not immigrating into the County)	habitat conversion (riparian habitat stress/reduction, shrubland to grassland, increased barren lands, aridification); increase fire risks; increase susceptibility to non-native invasion plants and animals	Covered area, covered species, covered activities, duration, BGO, take, AMM, Changed and unforeseen, monitoring, adaptive management

Climatic changes and effects	**Ecological implications**			
	Potential HCP-relevant effects on *natural systems* (species, habitats, biotic interactions)?	Potential HCP-relevant effects on *human systems* (behavior, economics, policy)?	Possible *landscape* scale effects that could affect species/systems within the HCP area?	*HCP sections (chapters)* that could be influenced by any of the changes or effects? How?
More frequent (shorter return interval), larger fires in desert scrub systems with invasive grasses and mustards	temporary destruction cryptogamic crust; destruction of aboveground plant tissue and native seed bank (not adapted to fire); further promotion of invasive grass and mustard species creating a synergistic effect between invasion and fire; destruction of Mojave Desert tortoise habitat; destruction of Joshua tree woodland	Potential decrease in human activity (less cover after fire), concentration of human activity in unburned areas, increased emphasis on fire management activities (policy/economics)	Conversion of desert scrub systems- synergistic effects between grass invasions and fire could result in conversion to annual grassland. This could result in loss of habitat for native species, including Covered Species.	Plan Area- is the reserve area large enough to accomodate for changes in ecosystems based on fire regime? Adaptive Management- monitoring changes in fire frequency to develop appropriate management measures. AMM focus on mapping of plant invasions, identification of vulnerable soils, documenting ecological effects of grass invasions while avoiding soil disturbance, controlling soil fires, and active restoration of native plant species (USGS 2011). Avoid, minimize, and mitigate - "Long-term success of post-fire vegetative restoration ... could require novel seed mixes of phenotypes, genotypes, and species adapted to future, not past, climates" (USGS 2011) Covered Activities- modify to reduce fire risk? Changed circumstances- fire return interval; BGOs
Less frequent (longer return interval) fires in desert scrub systems without invasive grasses and mustards	This scenario is predicted by models in which fine fuel buildup is expected to be reduced in the event of increased drought frequency preventing fine fuel build up (TNC 2011, Westerling and Bryant 2008; Westerling, in press). This scenario seems unlikely given the current spread of invasive grasses but may be the case in areas without invasion. Effects on natural systems predicted to be minimal, as these ecosystems are not adapted to regular fire intervals.	Human activities that would promote the spread of invasive plants (OHV use, recreation, roads, grazing, etc.) would make this scenario less likely.	N/A- would not expect to see much change as a result of this scenario (see Column B)	Unforeseen circumstances, monitoring
More frequent (shorter return interval), larger fires in riparian systems	Fires in low/mid elevation shrublands can lead to decreased short-term evapotranspiration, which can lead to increased groundwater recharge, increasing post-fire runoff and erosion. This can result in changes to riparian geomorphology, sedimentation, and water chemistry, and the spread of invasive species (NatureServe). Fires can promote tamarisk and other invasive species establishment and density leading to increase fire frequency (fuel loads) and facilitate fire spread (fuel continuity). Many of the hydrological regime changes could be exacerbated by fire.	Potential decrease in human activity (less cover after fire), concentration of human activity in unburned areas, increased emphasis on fire management activities (policy/economics); water quality standards and management post-fire (policy)	Conversion of upland habitat can result in changes to riparian geomorphology and water chemistry (see Column B), and may result in altered water courses/changes in the distribution of riparian habitat . Riparian species may differ in their ability to adapt to changes in hydrology; decrease riparian habitat quality with establishment and spread of non-native invasive species	Plan Area- is the reserve area large enough to accomodate for changes? Adaptive Management-monitoring changes in fire frequency to develop appropriate management measures. AMM could include mapping of plant invasions, identification of changes in water chemistry, documenting ecological effects of grass and tamarisk invasions, controlling soil fires, and active restoration of native plant species (USGS 2011). AMM - "Long-term success of post-fire vegetative restoration ... could require novel seed mixes of phenotypes, genotypes, and species adapted to future, not past, climates" (USGS 2011) Covered Activities- modify to reduce fire risk? BGOs; changed circumstances

Climatic changes and effects	**Ecological implications**			
	Potential HCP-relevant effects on *natural systems* (species, habitats, biotic interactions)?	Potential HCP-relevant effects on *human systems* (behavior, economics, policy)?	Possible *landscape* scale effects that could affect species/systems within the HCP area?	*HCP sections (chapters)* that could be influenced by any of the changes or effects? How?
More frequent (shorter return interval), larger fires in blackbrush systems with invasive grasses and mustards	destruction of aboveground plant tissue and native seed bank (not adapted to fire); further promotion of invasive grass and mustard species creating a synergistic effect between invasion and fire	Potential decrease in human activity (less cover after fire), concentration of human activity in unburned areas, increased emphasis on fire management activities (policy/economics)	Conversion of blackbrush systems- synergistic effects between grass invasions and fire could result in conversion to annual grassland. This could result in loss of habitat for native species, including Covered Species.	Plan Area- is the reserve area large enough to accomodate for changes? Adaptive Management-monitoring changes in fire frequency to develop appropriate management measures. AMM could include mapping of plant invasions, identification of vulnerable soils, documenting ecological effects of grass invasions while avoiding soil disturbance, controlling soil fires, and active restoration of native plant species (USGS 2011). AMM - "Long-term success of post-fire vegetative restoration ... could require novel seed mixes of phenotypes, genotypes, and species adapted to future, not past, climates" (USGS 2011) Covered Activities- modify to reduce fire risk? BGOs; changed circumstances
Less frequent (longer return interval) fires in blackbrush systems without invasive grasses and mustards	This scenario is predicted by models in which fine fuel buildup is expected to be reduced in the event of increased drought frequency preventing fine fuel build up (TNC 2011, Westerling and Bryant 2008; Westerling, in press). This scenario seems unlikely given the current spread of invasive grasses but may be the case in areas without invasion. Effects on natural systems predicted to be minimal, as these ecosystems are not adapted to regular fire intervals.	Human activities that would promote the spread of invasive plants (OHV use, recreation, roads, grazing, etc.) would make this scenario less likely.	N/A- would not expect to see much change as a result of this scenario (see Column B)	Unforeseen circumstances, monitoring
Greater severe flood variability due more frequent and/or extreme precipitation events	scouring/alteration of habitat features and quality, mortality of individuals during the flood, decreased reproductive success (nests washed away in flood; nesting behavior disrupted; annual but if they become more frequent could compound over the years)	water quality monitoring and clean-up post-flood; infrastructure repair and maintenance from flood damage; disaster planning/prevention (economics/policy)	temporary and permanent conversion or decreased habitat quality in flood areas; local declines in covered species populations in affected areas, declines (temporary or permanent) in food sources affecting covered species	Conservation Strategy- Adaptive management plan, mitigation/minimization measures, reserve system (large enough to cover changes), BGOs; Changed circumstances and unforeseen circumstances (500 year flood); Covered Activities - agriculture and development; Covered Species- range shifts and species distributions; Permit Duration- 50 years permit term may actually see these changes during term, take estimations
Variation in seasonal precipitation patterns	timing of water availability could lead to physiological stress, reproductive success (pollinators/blooming times too), prey availability (timing of rains at the end of summer, timing of rain for plant growth/reproduction)	irrigation timing/needs for agriculture, golf courses or other landscaping/recreation; less predictable water may mean more infrastructure or other development to provide water in all circumstances (economics/policy); water use policy	local population declines, range shifts	Conservation Strategy- Adaptive management plan, mitigation/minimization measures, reserve system (large enough to cover changes), BGOs; Changed circumstances and unforeseen circumstances (predictions of rainfall patterns); Covered Activities - agriculture and development; Covered Species- range shifts and species distributions; Permit Duration- 50 years permit term may actually see these changes during term, take estimations

Worksheet 3. Impacts: Climatic changes, biological effects, and implications by HCP section. Using what you came up with in the previous worksheets, think about what various climatic changes and effects might mean for each section of the HCP, and make notes about questions and concerns to keep in mind as you work through the HCP. The first page focuses on physical changes, while the second focuses on biological effects. *The climatic changes and effects given here are illustrative and should be adapted to reflect the region and HCP in question.*

Worksheet 3a. Impacts: Climatic changes and implications by HCP section

Implications for each HCP section (*feasibility and effectiveness*)	**Climatic changes and effects**						
	Precipitation *Intensity, seasonality, type, max, min*	**Air temperature** *Max./min, night/day, seasonality*	**Drought** *Intensity, frequency, duration*	**Flood** *Intensity, frequency, duration*	**Fire** *Frequency, size, intensity, timing*	**Streamflow** *Timing, volume, variability*	**Seasonality** *Earlier spring, later fall, longer growing season, etc.*
Covered area	will shifts in seasonality, amount, etc affect breeding reproduction of wildlife/ plant vigor and vitality; is plan area large enough to accomodate these changes?	resiliency of plan area- is there room in the reserve for these species' ranges to change in response to temperature increases? corridors for species to migrate to newly suitable/changing habitats?	is plan area large enough to provide adequate habitat for covered species as drought diminishes value of habitat	Depending on the effectiveness of mitigation measures ameliorationg the impacts of the more intense and frequent floods will need to be monitored to determine habitat quality	resiliency of plan area- is there room in the reserve for these species' ranges to change in response to changing habitats as result of fire? fire may be major impact in JT habitat, do we have reserve system to manage this? or what is impact here, should plan area be reduced to avoid JT impacts?	Monitoring/adaptive management will need to ensure streamflow is not altered so that plan area does not need to be modified in future	Is the plan area large enough or include adequate habitat to allow for species range shifts that may occur in response to climate shifts? How can we manage for these changes and will the changes lead to habitat no longer present in Plan Area?
Covered species	will species be able to adapt to precipitation changes, such that it may affect their coverage?	included species which may see declines in the region/potential for listing as environmental stressors such as temperature increase; species responses may also change in the future; Plan Area covers extrememly wide area of County, should we consider limiting Plan Area to areas County will impact (remove DOD lands, etc)?	will species be able to adapt to prolonged drought, such that it may affect their coverage?	will flood intensities alter species habitat such that habitat is no longer suitable and species can continue to be included	included species which may see declines in the region/potential for listing as environmental stressors; Joshua tree will be impacted by fire, can we address this sufficiently in reserve system or adaptive management? Potential for species to survive/adapt to increase fire frequency or intensity?	will changes in stream flow alter species habitat such that habitat is no longer suitable and species can continue to be included	will species be able to adapt to seasonality changes? shifts between pollinator emergence and bloom periods? timing of rain? species were included that may be susceptible to these future changes and may lead to listing. How can we manage for these changes and will the changes lead to habitat no longer present in Plan Area and species should not be covered?
Covered activities	will precipitation changes affect when or how covered activities are conducted? Seems unlikely, with exception of water use policies	ensure we are including energy infrastructure activities which may need to increase to handle future rise in energy for cooling; do we need to place limits on certain activities planned for coverage which may increase risk as temps rise?	will drought changes affect when or how covered activities are conducted? Seems unlikely, with exception of water use policies	will changes in flooding affect when or how covered activities are conducted? Will need to review Las Vegas Wash flood control plan	will covered activities increase fire frequency as habitats become more susceptible/combustable? thresholds for activities for which they are no longer covered? fire management plans?	will changes in stream flow affect when or how covered activities are conducted? Will need to review Las Vegas Wash flood control plan	changes in seasonality may impact how covered activities are conducted or what activities are conducted. have we included all activities that might occur (increased need for irrigation infrastructure/timing of irrigation, etc)?
Duration	will various precipitation changes caused by climate change be able to be addressed through adaptive management, will uncertainties be delineated such that USFWS can grant assurances for 50 year permit duration?	permit term may see changes and effects of temperature - other sections will need to be robust (large enough reserve area, adapative management, changed/unforeseen) to account for conditions	will various habitat changes caused by drought be able to be addressed through adaptive management, will uncertainties be delineated such that USFWS can grant assurances for 50 year permit	will various habitat changes caused by flooding be able to be addressed through adaptive management, will uncertainties be delineated such that USFWS can grant assurances	permit term may see changes and effects of temperature - other sections will need to be robust (large enough reserve area, adapative management, changed/unforeseen) to account for conditions; can adaptive management plan address these future conditions in permit timeframe?	will habitat changes caused by changes in stream flow be able to be addressed through adaptive management, will uncertainties be delineated such that USFWS can grant assurances	permit term may see changes and effects of seasons - other sections will need to be robust (large enough reserve area, adapative management, changed/unforeseen) to account for conditions; can adaptive management plan address these future conditions in permit timeframe?

Implications for each HCP section (*feasibility and effectiveness*)	**Climatic changes and effects**						
	Precipitation *Intensity, seasonality, type, max, min*	**Air temperature** *Max./min, night/day, seasonality*	**Drought** *Intensity, frequency, duration*	**Flood** *Intensity, frequency, duration*	**Fire** *Frequency, size, intensity, timing*	**Streamflow** *Timing, volume, variability*	**Seasonality** *Earlier spring, later fall, longer growing season, etc.*
BGO (Biological Goals and Objectives)	will anticipated changes in precipitation be predicted inclusively enough to ensure each of covered species viability is maintained or enhanced?	include objectives related to climate refugia? can we predict habitat changes and species response from temperature well enough to have measurable goals and maintain species viability?	will changes in available habitat caused by drought be predicted inclusively enough to ensure each of covered species viability is maintained or enhanced?	will changes in available habitat caused by flooding be predicted inclusively enough to ensure each of covered species viability is maintained or enhanced?	can we predict what fire may do to the landscape and the species response? will changes to habitat lead to conversions and species viability able to be managed/maintained? measureable objectives may relate to distribution of non-native plants that increase fire susceptibility.	will changes in available habitat caused by changes in stream flow be predicted inclusively enough to ensure each of covered species viability is maintained or enhanced?	can we predict habitat changes or species response to changes in seasons well enough for measurable objectives? What objectives may be necessary to ensure species viability with changes in seasons?
Take (includes cumulative impacts)	will changes in precipitation be predicted inclusively enough to ensure permit will not need to be amended in future?	species may have increased stress and higher susceptibility in future, will take increase? will calculations/estimations of take need to change with changing conditions?	will changes in available habitat caused by drought be predicted inclusively enough to ensure permit will not need to be amended in future?	will changes in available habitat caused by flooding be predicted inclusively enough to ensure permit will not need to be amended in future?	will take limits need to be adjusted in the future if habitat decreases as a result of fire? do the take estimations include these changing conditions?	will changes in available habitat caused by stream flow changes be predicted inclusively enough to ensure permit will not need to be amended in future?	species may have increased stress and higher susceptibility in future, will take increase as seasons shift? can we anticipate species response and accurately estimate take without needing to amend permit?
Avoid, minimize, and mitigate	will changes in precipitation be predicted inclusively enough to ensure adequate AMM measures are incorporated into conservation strategy?	avoidance of certain habitats may become increasingly important, do we craft threshold-type measures? temperature changes may facilitate non-native plants, measures should include focus on reducing potential spread of plants/fire risk; does mitigation need to change with temperature? maybe not just habitat preservation, include water stations? artificial burrows?	will changes in available habitat caused by drought be predicted inclusively enough to ensure adequate AMM measures are incorporated into conservation strategy?	will changes in available habitat caused by flooding be predicted inclusively enough to ensure adequate AMM measures are incorporated into conservation strategy?	invasive species as a result of fire, can we manage/mitigate this with changing fire regimes/intensity? post-fire restoration/seeding, fire/fuel management plans to minimize impacts. can we craft AMM to address changes from fire?	will changes in available habitat caused by changes in streamflow be predicted inclusively enough to ensure adequate AMM measures are incorporated into conservation strategy?	habitat availability may change, will avoidance/minimization measures need to be updated with changing conditions? how can mitigation be built to address shifts in timing of precipitation or pollinators?
Adaptive management	will AM strategy be flexible enough to encompass uncertainties surrounding future changes brought about by precipitation changes?	can we identify thresholds or other management shift triggers? needs for managing/building temperature refugia? what are the unknowns for temperature future?	will AM strategy be flexible enough to encompass uncertainties surrounding future changes brought about by drought?	will AM strategy be flexible enough to encompass uncertainties surrounding future habitat changes brought about by changes in flood intensity, etc?	can AM be built to address uncertainties from fire and resulting habitat changes? can we identify thresholds for changes observed from fire to adjust management? what are other potential management strategies to reduce fire risk or manage post-fire?	will AM strategy be flexible enough to encompass uncertainties surrounding future habitat changes brought about by changes in streamflows?	can we identify thresholds or other management shift triggers? needs for managing/building habitat refugia if seasons shift habitat suitability? what are the unknowns for seasonality in relation to plant reproduction and survival? can AM address these uncertainties?

Implications for each HCP section (*feasibility and effectiveness*)	**Climatic changes and effects**						
	Precipitation *Intensity, seasonality, type, max, min*	**Air temperature** *Max./min, night/day, seasonality*	**Drought** *Intensity, frequency, duration*	**Flood** *Intensity, frequency, duration*	**Fire** *Frequency, size, intensity, timing*	**Streamflow** *Timing, volume, variability*	**Seasonality** *Earlier spring, later fall, longer growing season, etc.*
Monitoring	will monitoring be designed such that it can be conducted cost effectively and deal with the uncertainties surrounding species viability in a changing environment? Will monitoring be able to detect species susceptibility to changes in precipitation (will precip changes affect species susceptibiity to disease (existing diseases or unknown but in surrounding states)?	will monitoring also need to focus on measuring species stress, water availabilty? how to measure effects/changes from temperature increases? tortoise sex ratios? can we detect and measure in a cost effective way these changes?	will monitoring be designed such that it can be conducted cost effectively and deal with the uncertainties surrounding species viability in a changing environment? Will monitoring be able to detect species susceptibility to changes brought about by drought (will drought change habitat quality such that species viability is impacted)?	will monitoring be designed such that it can be conducted cost effectively and deal with the uncertainties surrounding species viability in a changing environment? Will monitoring be able to detect changes in species habitat quality brought about by changes in flooding intensity, etc (will flooding change habitat quality such that species viability is impacted)?	can we detect and measure the changes that result in species susceptibility? what factors might these be? is monitoring related to fire also needing to focus on fire risk (invasive plant species and fuel build up) in addition to fire frequency?	will monitoring be designed such that it can be conducted cost effectively and deal with the uncertainties surrounding species viability in a changing environment? Will monitoring be able to detect changes in species habitat quality brought about by changes in stream flows (will stream flow change habitat quality such that species viability is impacted)?	will monitoring also need to focus on measuring species stress, water availabilty? how to measure effects/changes from shifts in seasons (precipitation patterns, earlier or shorter springs, longer summers)? can we detect and measure in a cost effective way these changes?
Changed and unforeseen	can sideboards be established on precipitation changed circumstances such that they be differentiated from unforeseen circumstances?	will we need to incorporate temperature extremes or increased overall temperatures as changed and what limits for that versus unforeseen? use number of heat waves per year consistently for X number of years?	can sideboards be established on changed circumstances due to drought such that they be differentiated from unforeseen circumstances?	can sideboards be established on changed circumstances due to flood such that they be differentiated from unforeseen circumstances?	What constitutes changed - set fire return intervals that are foreseen? or fire intensity and habitat conversion for unforeseen? fire size (acres burned) can also impact ability to reasonably respond and manage post-fire, need to consider limits for this as well	can sideboards be established on changed circumstances due to streamflow such that they be differentiated from unforeseen circumstances?	how to define what are changed circumstances for foreseeable shifts in seasons? timing of plant growth, timing of rains? and what would define unforeseen changes? length of summer/hot season, when mismatch between rainfall and when plants need for growth, mismatch between blooming and pollinators?

Worksheet 3. Impacts: Climatic changes, biological effects, and implications by HCP section. Using what you came up with in the previous worksheets, think about what various climatic changes and effects might mean for each section of the HCP, and make notes about questions and concerns to keep in mind as you work through the HCP. The first page focuses on physical changes, while the second focuses on biological effects. *The climatic changes and effects given here are illustrative and should be adapted to reflect the region and HCP in question.*

Worksheet 3b. Impacts: Biological effects and implications by HCP section

Implications for each HCP section (*feasibility and effectiveness*)	**Biological effects of climatic changes**				
	Species *Changes in diet, range, behavior, migration timing*	**Species interactions** *Changes in interaction strength, changes in key predator or prey species*	**Ecological communities** *Loss of key habitat types, spread of non- native species*	**Disease, parasites, non-native species** *New diseases, range shift, changes in virulence and transmission*	**Human behavior or policy responses** *Changes in water pricing and permits, development patterns, energy markets*
Covered area	Species may adapt to climate-related food availability by changing migration timing (BUOW, SWFL, YBCU, AZBV). Territory size may increase due to decrease of food availability, increasing intraspecific competition and reducing individual's fitness. Ranges may shift as suitable habitat increases, decreases, or shifts location- may be related more to elevational range shifts in response to increased annual temperatures (such as Joshua tree). Plan Area/Reserve Area sufficient to encompass species range shifts (elevational, in response to fire, etc.)	Potential shifts in ranges of both Covered Species and obligate symbiotic species (for example Joshua tree and yucca moth) may need to be considered simultaneously to determine whether the Covered Area is sufficient to support the Covered Species. Shifts in the ranges of predator species (such as corvids) may also shift suitable habitat for Covered Species (such as desert tortoise).	Quality of habitats may decrease in Plan Area or suitable habitat may shift outside of Plan Area (higher elevation species like JT this could be a concern). Is the reserve system large enough to encompass these shifts?	Changes in temperature and precipitation may open up new areas to invasion by disease, invasive insects, etc. Is the reserve system adequate to have species protections/management in multiple areas in case some areas impacted by these factors?	Potential for economic interests (water, energy) to shift location of impacts out of Plan Area (development prefer to be out of lower elevations)?
Covered species	Abundance of species may increase or decrease due to food availability, nesting habitat, etc. Some non-covered species may experience unanticipated population declines and require new protections. Have we covered all species which may shift into and become more common in Clark County and that may be or become listed?	Potential for non-covered species to impact covered species through competition for nesting, food. Other species may adapt in feeding or nesting habits, also resulting in increased interspecific competition. Shifts in ranges or emergence timing between Covered Species and obligate symbiotic species (e.g., Joshua tree and yucca moth) could result in reduced pollination/ reproductive success	Covered species habitats may decrease in size, quality, suitability. Habitats may become more fragmented, increasing potential for negative impacts from edge effects, decreased genetic exchange.	Covered species may become more susceptible to diseases if under increased physiological stress due to temperature/ precipitation changes. At what level should monitoring a new threat be escalated to management or shifts in management? Novel diseases or parasites/pests may emerge in Clark County with changes in conditions - changed or unforeseen circumstances to outline these limits?	Potential for economic interests (water, energy) to increase impacts to covered species (location or amount of activities change) and reactions become more severe? Water management as severe droughts become more common and indirect impacts to covered species?
Covered activities	Potential for increased conflict between covered activities and covered species as some may have range shifts or be under increased stress.	Covered activities may bring an increase in interspecific competition if these encourage establishment of other non-native or invasive species.	Threat of spread of non-native species may increase due to covered activities/climate change. Covered activities could incidentally increase this threat or increase risk of fire. Will covered activities related to energy or water increase with future demands and need to be limited if impacts to species increase?	Covered activities may be a vector in introducing new diseases, parasites, non-natives.	Covered activities may need to be modified in response to climate change (e.g., increase in energy production, water demand). Are federal/state/local water and energy policies in line with the HCP in the event of extreme drought and heat causing unforeseen demands?

Implications for each HCP section (*feasibility and effectiveness*)	**Biological effects of climatic changes**				
	Species *Changes in diet, range, behavior, migration timing*	**Species interactions** *Changes in interaction strength, changes in key predator or prey species*	**Ecological communities** *Loss of key habitat types, spread of non- native species*	**Disease, parasites, non-native species** *New diseases, range shift, changes in virulence and transmission*	**Human behavior or policy responses** *Changes in water pricing and permits, development patterns, energy markets*
Duration	permit duration= 50 years. Some species may be more adaptable than others in modifying behavior, range, migration or ability to handle increased stresses. Have we covered all species that may see declines/become listed in 50 years?	Difficult to predict all potential changes in interactions between covered and non-covered species over the duration of the plan, but permit term is long enough to encounter may changes (pollinator changes, preadtor/prey) - can adaptive management be flexible enough to capture changes within permit term?	Longterm shifts in ecological communities difficult to predict. Major stochastic events may yield unpredictable results (e.g., severe flooding or severe drought permanently wiping out riparian woodlands, loss of groundwater/water table lowering impacting desert oases or spring systems, wildfires).	Impossible to predict introductions of diseases, parasites, non-natives over the course of 50 years, but existing diseases may increase virulence (e.g. respiratory on DT if DT body condition lowers from stresses caused by climate change) or establishment/spread of non-native plants could increase with changing conditions. is adaptive management flexible to capture changes? unforeseen circumstances to set limits on what is foreseen?	Changes in resource (water/energy/mineral/food) demand resulting from climate change and/or human development patterns may exceed what is anticipated by the HCP - limits on covered activities if take increases? Policies needed to limit these impacts (fire management, water management)?
Biological Goals and Objectives (BGO)	Are BGOs measurable and attainable for viablity of covered species with climate and species adaptability uncertainties?	Do the BGOs need to consider obligatory symbiotic species or predator/prey dynamics in measuring success of goals or species sustainability?	Will changes in available habitat caused by future climate conditions be predicted inclusively enough to ensure covered species viability is maintained? Are BGOs objectives measuring indirect items that may impact covered species viability?	Are BGOs measurable and attainable for viablity of covered species with potential impacts from introductions/novel species interactions?	Will new policies need to be implemented to ensure BGOs? Do BGOs consider potential changes from humans and policies that might be implemented from future climate conditions? Are these meaureable and maintain species viability?
Take (includes cumulative impacts)	species may have increased stress and higher susceptibility in future, will take increase? will calculations/estimations of take need to change with changing conditions? Could unanticipated changes of Covered Species unrelated to covered activities (decreased genetic variation, changes in phenology, etc.) lead to greater amounts of take/higher sensitivity to Covered Activities - need to put in limitations in unforeseen circumstances?	Does anticipated level of take account for indirect effects resulting from changes to symbiotic, predator, and/or prey species? What is foreseen and how to describe limits for changed annd unforeseen circumstances?	Does take estimated as a result of covered activities include potential for increase take from changes in ecological communities as a result of climate conditions? What is foreseen? How can descrive changed and unforeseen circumstances related to unanticipated changes in take estimates as a result changes in ecological communities?	Could species be more sensitive as a result of new disease, parasites, non-natives and take from covered activities increase more than anticipated? Can predict well enough to not need amendment to take levels? How describe what is foreseen and unforeseen as a result of novel diseases or invasives?	Will increased demand for water/energy result in changes to the estimated take and can this be predicted well enough to not need to amend take levels in the future? Changes in recreational patterns/locations? How describe what is foreseen and unforeseen?
Avoid, minimize, and mitigate	Will AMM measures be flexible enough to account for unforeseen changes in species' diet, range, behavior, migration, etc.? Thresholds for when AMM need to be adjusted (work windows or other timing measures that may need to shift in future)	Will AMM need to include species interactions and can these be predicted accurately for AMM to reduce impacts that may occur indirectly from predator/prey or pollinators? What are foreseen/ unforeseen changes in species' interactions or thresholds?	Will AMM measures include changes in habitat quality or ways to prevent habitat degradation from non-native species establishment?	Are AMM strong enough to reduce potential spread of novel disease/species introductions? Will flexibility in AMM be included should adjustments need to be made to reduce potential impacts or spread of novel disease, parasites, non-native species? Should AMM include funding for research and treatment of new diseases, parasites, non-natives?	Will the AMM adequately account changes in human behavior/policy responses due to climate change? Have those changes been adequately identified and analyzed?

Implications for each HCP section (*feasibility and effectiveness*)	**Biological effects of climatic changes**				
	Species *Changes in diet, range, behavior, migration timing*	**Species interactions** *Changes in interaction strength, changes in key predator or prey species*	**Ecological communities** *Loss of key habitat types, spread of non- native species*	**Disease, parasites, non-native species** *New diseases, range shift, changes in virulence and transmission*	**Human behavior or policy responses** *Changes in water pricing and permits, development patterns, energy markets*
Adaptive management	Are adaptive management techniques capable of providing the requisite habitat conditions for highly localized/specialized Covered Species in the face of changes resulting from climate change (e.g. St. George's blue eyed grass and receding groundwater levels)? Are AM flexible enough to encompass uncertainties surrounding future climate conditions and resulting changes/needs of species?	Intense management may be needed in response to negative interspecific interactions with covered species. Are AM flexible enough to encompass uncertainties surrounding future climate conditions and resulting species interactions? Can thresholds for shifts in management be identified and what would need to be measured (e.g. pollination and Joshua tree)?	Does AM incorporate potential to handle habitat restoration efforts even if large-scale or long-term needed? Is adequate funding provided? Multiple catastrophic event within small timeframes may stress budgets, causing the effectiveness of these programs to drop below levels necessary to achieve BGOs. Are the AM flexible enough to identify and address future uncertainties of changing habitats in response to climate conditions?	Are AM flexible and robust enough to handle novel pests/diseases or increased susceptibility to pests/diseases under future climate conditions (lower body conditions may increase disease virulence)? Major outbreaks may stress budgets causing the effectiveness of these programs to drop below levels necessary to achieve BGOs.	Does AM incorporate flexibility of new policies/human behavior on management needs? Changes in preferred development area? Proactive for fire/fuel management or water management? Can thresholds be identified for when shifts in management strategy should occur?
Monitoring	Species' behavioral shifts (e.g., underground longer, activity shifts toward cooler night temperatures) may make monitoring more difficult and need to change methods. May need to modify monitoring protocols/locations to account for shifts in range. Is monitoring structured to allow updates in methods with changes in species? Abillity to detect reproductive success in long-lived species (desert tortoise and joshua tree) or changes in sex ratios (desert tortoise and temperature effects)? Do we have adequate baseline data to determine if changes in lesser studied species are normal variation or climate related?	Monitoring would need to take into account negative/positive species interactions. Will monitoring target data to detect changes in interspecific interactions?	will data collected allow for the identification/detection of regular, cyclical shifts in the state of a habitat versus a permanent transition of habitat type or quality?	Will monitoring include disease or pest data to identify novel pests or major outbreaks? Or species response to disease and pests both novel and existing? Establishment of new non-native species and risk for invasion?	Will monitoring also include data for changes in human activity and needs that may drive changes in impacts to species? Foresee these impacts (increasing energy demand and need for infrastructure development or new energy projects)?
Changed and unforeseen	Do we have adequate baseline data to plan and describe what is foreseeable? What are limits to foreseeable changes in species and adaptibility versus unforeseen? How big of a range shift?	At what point do we determine that interspecific interactions become changed or unforeseen? Is there adequate data to determine this and what should be included in monitoring to understand? Prey availability or pollinator changes?	What is the threshold on habitat loss or degradation from natural or non-covered activities (stand changing fires, invasive species establishment) to be considered unforeseen? Short and long-term variation in key habitat acreage can be expected. Does loss of half of a key type constitute unforeseen? All?	Difficult to predict impacts of new diseases, parasite, invasives on covered species. Which diseases or pests may be known and not established in Clark County (or not extrememly virulent/damaging but could be in future climate conditions)? Establish limits for what would be changed conditions for existing diseases. Establish limits of when a new disease may reach unforeseen circumstances.	How do we account for or determine the 'changed and unforeseen' threshold for human-caused disasters (e.g., large fires, chemical spills, etc.)? Are other federal/state/local water/energy policies in line with the HCP in the case of extreme drought or heat? Novel activities and their impacts, water management and sources?

Worksheet 4. Summarizing key climate questions/considerations.

	Key climate considerations	Options for addressing
Covered area	Is the reserve system sufficient to capture species range shifts which may occur in future climate conditions? Will the Plan Area (or reserve system) capture movement corridors to allow species shifts?	Ensure reserve system includes elevation and other ranges and is large enough to allow for range shifts. If available for species (potentially desert tortoise), utilize future habitat prediction models to assess reserve system.
Covered species	Will climatic changes/effects increase risk to species enough that allowing any incidental take is no longer prudent?	This could be a concern for range limited and extreme habitat specialists (plant species), review future climate projections and ensure adaptive management plan includes incorporation of assisted migration and reporting includes updates on habitat conditions/shifts.
Covered activities	Will infrastructure or other linear projects limit ability for movement corridors/migrations and result in additional take in 20 years?	This could be a concern for range limited and spring-associated species (plant species), review future climate projections and ensure adaptive management plan includes incorporation of assisted migration and reporting includes updates on habitat conditions/shifts. Review ability to procure water rights in reserve systems as mitigation measure. Include corridor and movement analyses into take/mitigation analysis and reserve planning.
Permit Duration	Climate-related uncertainty about water availability in desert ecosystems may make it difficult to predict species success and habitat locations for mitigation. Similar uncertainty for potential invasive species management and fire.	Ensure flexibility in adaptive management program to make adjustments to mitigation actions if necessary to better reflect changes observed. Ensure large enough reserve system to allow for shifts and natural adaptation process to occur within the system. Ensure adequate funding for mitigation measures if effort is needed to increase related to invasive species management.
Mitigation Duration	Does the length of mitigation incorporate uncertainties for climate future and long-lived species?	Include path for continued monitoring after permit expiration to ensure reserve system functioning for long-lived species with realistic and well-defined success criteria and opetions if climatic changes may require adjsutments including more intensive management options.
BGOs	With invasive species potentially becoming a major concern with climate change and increased fire in the system, will the BGOs be achievable related to management for the variety of species habitats? If species such as Joshua tree display a measurable range shift increasing the lower elevation limit, will the Plan Area be able to achieve goals for Joshua tree and other species?	Ensure flexibility in adaptive management program to make adjustments to mitigation actions if necessary to better reflect changes observed. Ensure large enough reserve system to allow for shifts and natural adaptation process to occur within the system. Ensure adequate funding for mitigation measures if effort is needed to increase related to invasive species management. Review potential to have higher elevation areas in reserve system for species in blackbrush or Joshua tree associated ecosystems.

Take (incl. cumulative impacts)	Will infrastructure or other linear projects limit ability for movement corridors/migrations related to climate refugia? Could changing precipitation patterns change the intensity of project-associated erosion or how far sediments travel in wash systems? Will water use affect groundwater systems and result in take of spring-associated and other water-dependent species?	Review future habitat models and identify potential migration corridors, design linear projects to limit barriers to movement and reduce potential for indirect effects to populations (raised roadways, wildlife culverts, etc). Include evaluation planning for development near washes for extreme precipitation events. Include monitoring of groundwater and analyze thresholds to manage for and potential for limits on pumping/water diversion if necessary in reserve system.
Avoid, minimize and mitigate	Could shifts in breeding seasons change seasonal work windows? Could shifts in activity times of wildlife or blooming periods for plants result in false negative surveys? Will adjustments need to be made for habitat types that require surveys for target species (range shifts mean species are in new habitat types)?	include early and late season surveys as part of monitoring or survey protocol and allow flexibility to adjust work windows or survey protocols as data indicate need for updates.
Adaptive management	Is the AM plan specific enough about climate-related uncertainties it's designed to address? Are there adequate resources available to monitor and respond to management needs, and what may happen if successful management no longer seems feasible (invasive plants dominating landscapes).	Identify thresholds if these are known, and for unknowns outline the uncertainties and what triggers may be observed to reevaluate management and possible responses. Monitoring and early management to control invasives, and clear outlines of when management plan should be reeavluated for success, adjustments to frequency, and if stand changing fires occur (threshold event) potential alternatives in management type. Describe triggers for when more intensive management including assisted migration may be implemented.
Monitoring	Will monitoring protocols continue to tell us what we want to know if individuals change when and where they're found as a result of climatic or other changes? Will monitoring detect if reproductive success is changing for long-lived species or pollinator-dependent species?	include early and late season surveys as part of monitoring or survey protocol to detect changes in breeding seasons or blooming periods. Monitoring should also inclue data to understand daily shifts in activity patterns if daytime high temperatures result in less daytime activity of diurnal wildlife. Include research to understand germination rates over time and data on invertebrate assemblages if pollinator species are not known.
Changed and unforeseen	Is the HCP specific enough about what changes are foreseeable and what the responses to them would be with respect to climate change?	Review data to identify potential known thresholds and know what changes may be foreseen and those that may be unforeseen. Describe variability related to precipitation, temperatures maximums/minimums, and range shifts. Describe which species are have uncertainties in responses to change and which may be more resilient or known potential responses. These can be basis for describing known vs unforeseen changes.