Appendix P

Climate Change Context for the DRECP BLM LUPA

TABLE OF CONTENTS

Section **Page No.**

INTENTIONALLY LEFT BLANK

PREFACE

This appendix provides an overview of the current state of climate change science described in the DRECP and a summary of adaptation and resiliency considerations and contributions of the DRECP BLM LUPA. Climate change science and the study of the ecological effects of climate change is a vast and rapidly advancing field of study, and this appendix attempts only to describe aspects of the climate change context relevant to the BLM land use planning process. The Climate Change appendix from the Draft DRECP (Appendix P; September 2014) provided the climate change setting for the Draft DRECP, and is incorporated here by reference. Key elements of the Draft DRECP Appendix P are highlighted in this document as applicable; however, the full text of the Draft DRECP Appendix P document is not included in the DRECP BLM LUPA and FEIS. The context and discussion of potential greenhouse gas emissions from proposed actions are analyzed in the DRECP Proposed LUPA and Final EIS (see the Meteorology and Climate Existing Setting in Chapter III.3 and the Meteorology and Climate Impact Analysis in Chapter IV.3) and not included in this document.

P.1 SUMMARY OF CLIMATE CHANGE PROJECTIONS

As summarized in the Draft DRECP, the ecological setting of the Mojave and Colorado/Sonoran deserts is being altered by climate change:

> [T]he California deserts are expected to become warmer and may become drier...as climate change progresses (see Chapter III.3 and Appendix P; also Cayan et al. 2008; Weiss and Overpeck 2005). Species will need to cope with decreasing and less consistent water availability and an increasing number of days above current minimum temperatures. These two abiotic factors are among the primary determinants of species' range (e.g., Bowers and Turner 2001; Leslie and Douglas 1979; Turnage and Hinckley 1938). According to climate change models, conditions currently present in parts of the Colorado/Sonoran Desert are expected to expand to other parts of the Plan Area (Allen 2012), with an associated shift in vegetation (Notaro et al. 2012). [Section III.7.4 of Draft DRECP Biological Resources Existing Setting]
>
> As reported by numerous researchers and supported by dozens of past- and next-generation climate models, the North American deserts are expected to become warmer at faster rates than other regions of the country (Stahlschmidt et al. 2011). The latest climate projections from various sources agree that temperatures will increase in the Southern California deserts between 2°C and 5°C (Stralberg et al. 2009; Snyder and Sloan 2005; Snyder et al. 2004; Bell et al. 2004). [Section II.3.1.3.5.1 of Draft DRECP Monitoring and Adaptive Management Program]

Further evidence that climate change effects are happening in the planning area was presented in Appendix P of the Draft DRECP:

> Recent studies have shown that climate change has already affected southern California where regional increases in temperature (LaDochy et al. 2007) and vegetation shifts (Guida 2011, Kelley and Goulden 2008) have been observed. Guida (2011) observed over the last 30 years (1979-2008) an increase of 1.5° C in the average annual minimum temperature and a decrease of 3cm in the average annual precipitation in the Newberry Mountains, on the southeastern corner of the Mojave Desert transitioning to Sonoran conditions. Changes were more pronounced at high elevation and Guida (2011) concluded from his correlations between climate and species distributions that those species that relied the most on higher precipitation levels were likely already migrating to higher elevations in order to adapt to the on-going changes in climate. Similarly, Kelly and Goulden (2008) attributed to climate change the shifts in vegetation distribution they observed along the Deep Canyon Transect of Southern California's Santa Rosa Mountains between 1977 and 2007.

P.2 TYPES OF ECOLOGICAL EFFECTS

This section reviews the types of ecological effects anticipated as climate conditions change. As described in Chapter III.3 of the DRECP Proposed LUPA and Final EIS:

> Biological systems are strongly influenced by climate, particularly temperature and precipitation. Shifts in the habitat elevation or latitude, changes in the timing of growth stages, changes in abundance and community composition, and increased vulnerability to wildfires or pathogens are examples of biological responses influenced by warming temperatures (California EPA 2013).
>
> The changes in climate may have direct or indirect effects on species. These effects may be positive, neutral, or negative and may change over time, depending on the species and other relevant considerations, such as interactions of climate with other variables like habitat fragmentation (Franco et al. 2006; Galbraith et al. 2010; Chen et al. 2011). In addition to evaluating individual species, scientists are evaluating possible climate change-related impacts to, and responses of, ecological systems, habitat conditions, and groups of species. These studies acknowledge uncertainty (Deutsch et al. 2008; Berg et al. 2009; Euskirchen et al. 2009; McKechnie and Wolf 2009; Sinervo et al. 2010; Beaumont et al. 2011; McKelvey et al. 2011; Rogers and Schindler 2011).

A species' suitable habitat is influenced by numerous environmental factors that represent the ecological niche for that species (Weins et al. 2009; Elith and Leathwick 2009; Franklin et al. 2013). As described above and in the Draft DRECP, climate change is anticipated to modify the environmental factors of ecological niches, and for certain species and vegetation types, these changing conditions may be beyond their acceptable tolerances. What is currently suitable habitat may no longer be in the future, resulting in modified species distributions, species abundance, and inter-specific interactions across the landscape (Parmesan and Matthews 2006; Stralberg et al. 2009). The ability of species to respond and/or adapt to changing environmental conditions will determine future species distributions and community compositions.

As described in Chapter III.7 and the DRECP Baseline Biology Report (Appendix Q), climate change has been identified as a threat for many of the wildlife and plant focus species addressed in the DRECP Proposed LUPA and FEIS. Understanding species' vulnerabilities to changing climate conditions can inform the management of these resources and values during LUPA implementation.

A species' vulnerability is determined by its exposure to climate change effects (e.g., increased temperature, reduced water availability, vegetation community shifts), its sensitivity to those changes, and its capacity to adapt to those changes (Glick et al. 2011; Gardali et al. 2012; Barrows et al. 2014; Klausmeyer et al. 2011). Statewide climate vulnerability assessments for amphibians, reptiles, birds and fish have been undertaken using the NatureServe developed Climate Change Vulnerability Index (NCCVI) and the EPA vulnerability index frameworks (Gardali et al. 2012; Wright et al. 2013; Moyle et al. 2012; EPA 2009). The effect of climate change on mammals has been less systematically studied in California. Certain species have received detailed analysis regarding the likely effects of climate change (e.g., Mohave ground squirrel and bighorn sheep); however, other groups, like bat species, have received less attention in California (see Coe et al. 2012 for assessment of bats species in southeastern Arizona).

Existing vulnerability assessments for focus wildlife species, cross-walked to the equivalent CCVI ranking, are summarized in Table P-1. It should be noted that most existing studies for amphibians, reptiles, birds and fish are statewide in scope; therefore, the vulnerability index is indicative of their statewide vulnerability, which does not necessarily represent the vulnerability of the species within the DRECP area. When applied at the scale of the DRECP, the statewide vulnerability index must be interpreted with caution. Downscaled climate projection information may not accurately represent the changes at regional or local scales, and the effects of climate change on individual species may differ at the regional or local scale.

Table P-1
Summary of Wildlife Species Vulnerability to Climate Change

Species	Estimated Vulnerability
Amphibian/ Reptile[1]	
Agassiz's desert tortoise (*Gopherus agassizii*)	Likely Vulnerable
flat-tailed horned lizard (*Phrynosoma mcallii*)	Presumed Stable
Mojave fringe-toed lizard (*Uma scoparia*)	Presumed Stable
Tehachapi slender salamander (*Batrachoseps stebbinsi*)	Likely Vulnerable
Bird[2]	
Bendire's thrasher (*Toxostoma bendirei*)	Critically or Highly Vulnerable
burrowing owl (*Athene cunicularia*)	Likely Vulnerable or less
California black rail (*Laterallus jamaicensis coturniculus*)	Critically or Highly Vulnerable
California condor (*Gymnogyps californianus*)	Less Vulnerable or less
Gila woodpecker (*Melanerpes uropygialis*)	Critically or Highly Vulnerable
golden eagle (*Aquila chrysaetos*)	Likely Vulnerable or less
greater sandhill crane (*Grus canadensis tabida*)	Likely Vulnerable or less
least Bell's vireo (*Vireo bellii pusillus*)	Critically or Highly Vulnerable
mountain plover (*Charadrius montanus*)	Likely Vulnerable or less
Swainson's hawk (*Buteo swainsoni*)	Critically or Highly Vulnerable
tricolored blackbird (*Agelaius tricolor*)	Likely Vulnerable or less
western yellow-billed cuckoo (*Coccyzus americanus occidentalis*)	Critically or Highly Vulnerable
willow flycatcher (including southwestern) (*Empidonax traillii* (including *extimus*))	Likely Vulnerable or less
Yuma Ridgway's rail (*Rallus obsoletus yumanensis*)	Critically or Highly Vulnerable

Table P-1
Summary of Wildlife Species Vulnerability to Climate Change

Species	Estimated Vulnerability
Fish[3]	
desert pupfish (*Cyprinodon macularius*)	Highly Vulnerable
Mohave tui chub (*Siphateles* (*Gila*) *bicolor mohavensis*)	Highly Vulnerable
Owens pupfish (*Cyprinodon radiosus*)	Highly Vulnerable
Owens tui chub (*Siphateles* (*Gila*) *bicolor snyderi*)	Highly Vulnerable
Mammal[4]	
Desert bighorn sheep (*Ovis canadensis nelsoni*)	Likely Vulnerable
California leaf-nosed bat (*Macrotus californicus*)	Presumed Stable
Mohave ground squirrel (*Xerospermophilus mohavensis*)	Highly Vulnerable
pallid bat (*Antrozous pallidus*)	No published California assessment
Townsend's big-eared bat (*Corynorhinus townsendii*)	No published California assessment

1 Amphibians and Reptiles – Wright et al. 2013
2 Birds – Barrows et al. 2014; Siegel et al. 2014; Young et al. 2012; Gardali et al. 2012
3 Fish – Moyle et al. 2012
4 Mammals – Barrows et al. 2014; Esque et al. 2013; Epps et al. 2004

Standardized Vulnerability Classifications:

- Extremely Vulnerable = Critically vulnerable (Moyle et al. 2012), Severely vulnerable (Wright et al. 2013), Avian Vulnerability Ranking of 1 (Gardali et al. 2012); Predicted future range disappears entirely (Wright et al. 2013); Abundance and/or range extent within geographical area assessed extremely likely to substantially decrease or disappear by 2050.
- Highly Vulnerable = Highly vulnerable (Moyle et al. 2012), Greatly vulnerable (Wright et al. 2013), Avian Vulnerability Ranking of 1 (Gardali et al. 2012); Predicted future range represents 50-99% decrease (Wright et al. 2013); Abundance and/or range extent within geographical area assessed likely to decrease significantly by 2050.
- Moderately or Likely Vulnerable = Less vulnerable (Moyle et al. 2012), Moderately vulnerable (Wright et al. 2013), Avian Vulnerability Ranking of 2 (Gardali et al. 2012); Predicted future range represents 20-50% decrease (Wright et al. 2013); Abundance and/or range extent within geographical area assessed likely to decrease by 2050.
- Presumed Stable = Least vulnerable (Moyle et al. 2012), Slightly vulnerable to Presumed stable (Wright et al. 2013), Avian Vulnerability Ranking of 3 (Gardali et al. 2012); Predicted future range represents no greater than a 20% change (Wright et al. 2013); Available evidence does not suggest that abundance and/or range extent within the geographical area assessed will change (increase/decrease) substantially by 2050. Actual range boundaries may change.
- Increase Likely = Least vulnerable (Moyle et al. 2012), Slightly vulnerable to Presumed stable (Wright et al. 2013), Avian Vulnerability Ranking of 3 (Gardali et al. 2012); Predicted future range represents a greater than 20% increase (Wright et al. 2013); Available evidence suggests that abundance and/or range extent within geographical area assessed is likely to increase by 2050.

Currently there is no systematic assessment for vulnerability for the plant focus species in the DRECP area. Although CDFW assessed 156 rare species from across California using the Nature Serve vulnerability index (Anacker et al. 2013), none of the species studied were focus species within the DRECP area. Acknowledging that each species has individual resiliency, adaptation capacity, and vulnerability, the vulnerability of vegetation types to changing climate conditions can offer some indication of how individual plant species may respond. In Appendix P of the Draft DRECP, changes in the distribution of coarse-scale vegetation cover across the DRECP area was projected to occur as a result of changing climate conditions, including simulated shifts in herbaceous vegetation, scrub vegetation, and woody vegetation. Vulnerability of vegetation to changing climate conditions has also been assessed for specific natural desert scrub, wetland, and riparian vegetation types in the Mojave and Sonoran/Colorado deserts (Comer et al. 2012). Vegetation types characterized as highly vulnerable to climate change include Mojave mid-elevation desert scrub (includes Joshua tree woodlands), North American warm desert riparian woodland, North American warm desert mesquite bosque, and Sonora-Mojave creosotebush-white bursage scrub; all other vegetation types studied were characterized as moderately vulnerable to climate change (Comer et al. 2012).

Considering that vegetation shifts are expected to occur and numerous vegetation types are considered moderately to highly vulnerable in the DRECP area, the plant focus species (i.e., alkali mariposa-lily [*Calochortus striatus*], Bakersfield cactus [*Opuntia basilaris* var. *treleasei*], Barstow woolly sunflower [*Eriophyllum mohavense*], desert cymopterus [*Cymopterus deserticola*], little San Bernardino Mountain linanthus [*Linanthus maculatus*], Mojave monkeyflower [*Mimulus monkeyflower*], Mojave tarplant [*Deinandra mohavensis*], Owens Valley checkerbloom [*Sidalcea covillei*], Parish's daisy [*Erigeron parishii*], and triple-ribbed milk-vetch [*Astragalus tricarinatus*]) are likely to be exposed to changing habitat conditions resulting in vulnerability to changing climate conditions.

P.3 ADAPTATION AND RESILIENCY

This section outlines key adaptation and resiliency considerations used in developing the DRECP BLM Proposed LUPA, and summarizes the major contributions of the DRECP BLM Proposed LUPA to providing climate change adaptation and resiliency.

P.3.1 Adaptation and Resiliency Provided by the DRECP BLM Proposed LUPA

Adaptation and Resiliency Considerations for the DRECP Proposed LUPA

Traditional reserve design principles of conservation biology, as described in reserve design process for the Draft DRECP (Draft DRECP Appendix G), offer guidance on how conservation areas can facilitate climate change adaptation (Araujo 2009; Soulé 1985;

Soulé 1987; Noss et al. 1997; Margules and Pressey 2000; Groom et al. 2006). Conservation areas that are large and connected with minimum edges and that capture environmental gradients are more likely to allow species and vegetation to adapt to changing conditions.

Additionally, certain characteristics of the landscape can affect "vulnerability" to changing climate conditions. Topographic diversity, elevational gradients, distance to the ocean, stable water sources, and riparian corridors have been identified as landscape factors influencing climate change vulnerability at the landscape scale (Klausmeyer et al. 2011). Certain landscape features would serve as climate refugia where climate change effects would be less severe or the impacts would be ameliorated (see Draft DRECP Appendix P for modeled climate refugia for the DRECP area).

Conserving species and vegetation types within each ecoregion in which they occur is also considered to maintain genetic variability, which provides a reservoir for potential adaptation to climate change. Replication of conservation in many areas also provides refugia from which recolonization can occur if other occupied areas are extirpated through catastrophic or extreme environmental events such as fire and extended drought (see Draft DRECP Appendix D for a complete description of the reserve design principles used to develop the Draft DRECP).

Additionally as described in Section III.7.8 of the Biological Resources Existing Setting in the DRECP Proposed LUPA and Final EIS, the California Desert Connectivity Project was developed to provide a comprehensive and detailed habitat connectivity analysis for the California deserts (Penrod et al. 2012). This study included both least-cost corridor habitat permeability models for wildlife species and identification of a Desert Linkage Network using "land facet" methods based on the approach described by Beier and Brost (2010). The Desert Linkage Network are "swaths" of habitat of fairly uniform physical conditions that will interact with uncertain climate changes to maintain habitat for species and species' movement (Penrod et al. 2012). Habitat linkages were an important adaptation and resiliency consideration in developing the LUPA.

Adaptation and Resiliency Contributions of the DRECP BLM Proposed LUPA

The following highlights the DRECP Proposed LUPA considerations and contributions to climate change adaptation and resiliency for the biological resources in the California deserts:

- **Information and Data Development and Documentation:** The planning process used to develop the Draft DRECP and the DRECP Proposed LUPA was the vehicle for creating a database of information used to document the existing setting and support decisions of the LUPA. Understanding and characterizing existing ecological conditions was critical to developing elements of the LUPA that influence climate change adaptation and resiliency.

- The existing setting for biological resources, as documented in Chapter III.7 and Appendix Q (Baseline Biology Report), is based on the synthesis of existing published information and data, newly created information and data developed for the DRECP (e.g., new vegetation mapping [CDFG 2012], species distribution models [Appendix Q; DRECP Baseline Biology Report], and habitat linkage data [Penrod et al. 2012]), outside scientific input and review, and extensive stakeholder and public input and review.
- The existing setting information and data formed the foundation for developing the DRECP Proposed LUPA and will provide the baseline information to support LUPA implementation, including monitoring and adaptive management activities.
- The database of geospatial information has been shared with state and local agencies, industries, non-governmental organizations, and the general public, through the DRECP gateway, to facilitate other ongoing and future planning efforts.

- **Conservation Area Establishment:** The following highlights key contributions of the DRECP Proposed LUPA conservation designations to climate change adaptation and resiliency across the landscape, as described in Chapter II.3 and analyzed in Chapter IV.7 of the DRECP Proposed LUPA and Final EIS.
  - The DRECP Proposed LUPA would designate 4,966,000 acres of LUPA conservation designations on BLM-administered lands in the DRECP area, which is in addition to the 3,259,000 acres of existing conservation on BLM-administered lands in Wilderness Areas, Wilderness Study Areas, and Wild and Scenic Rivers. Assuming no less than 95% conservation within these designations, the BLM LUPA would conserve a total of 7,776,000 acres, which is 83% of the 9,415,000 acres of BLM-administered lands in the DRECP area (excludes designated Open OHV Areas).
  - DRECP Proposed LUPA biological conservation (i.e., existing conservation areas and conservation designations) would conserve 87% of the desert linkage network on BLM-administered land in the DRECP area, including 80% or greater coverage of the linkage network in eight out of ten ecoregion subareas.
  - DRECP Proposed LUPA biological conservation would conserve approximately 80% or greater for six out of the nine general vegetation groupings representing the range of vegetation types on BLM-administered lands in the DRECP area. Vegetation types and features that provide climate refugia are also well conserved by the DRECP Proposed LUPA, including 79% of riparian vegetation and 80% of seep/spring locations.

- DRECP Proposed LUPA biological conservation of would conserve 70% or more of focus species modeled habitat on BLM-administered lands in the DRECP area for 25 out of the 39 focus species, including 89% of bighorn sheep habitat, 88% of golden eagle habitat, and 88% of desert tortoise habitat. Species with habitat conserved at less than 70% by the DRECP Proposed LUPA include species that inhabit the Imperial Valley, Owens River Valley, and West Mojave regions characterized by predominantly non-BLM lands where LUPA conservation designations were not compatible with existing uses, designations, or land ownership.
- Environmental gradients are well represented in BLM LUPA biological conservation, including conservation across the range of elevations, slopes, aspects, and landforms.

The DRECP Proposed LUPA would conserve habitat linkages, vegetation, and species habitat in large, connected, intact conservation designations across the range of environmental gradients and ecoregional subareas in the California deserts, all of which contributes substantially to adaptation and resiliency to changing climate conditions. See Appendix D (DRECP LUPA Biological Conservation) and Section IV.7.3.2.2 (analysis of the ecological and cultural conservation designations for the Preferred Alternative) for detailed analyses of conservation provided by the DRECP Proposed LUPA.

- **Conservation and Management Actions:** The DRECP Proposed LUPA would establish Conservation and Management Actions (CMAs; see Section II.3.4.2 and Appendix H and Appendix L) that prescribe allowable uses and management of designated areas. Importantly as it relates to climate change adaptation and resiliency, the DRECP Proposed LUPA includes detailed and comprehensive biological resources CMAs for avoidance, minimization, and compensation that apply to the range of activities addressed under the LUPA. Implementation of the CMAs will bolster climate change adaptation and resiliency by stipulating where and how activities with the potential to impact biological resources are conducted and how the conservation designations will be managed.
- **Implementation:** An important component of LUPA implementation is the Monitoring and Adaptive Management Program, as described in Section II.3.6. Establishing the implementation structure and framework for monitoring and adaptive management creates the mechanism through which climate change adaptation and resiliency tools can be developed and applied.

P.3.2 Types of Adaptation and Resiliency Tools

A variety of tools are currently available, and will be developed in the future, to assist BLM in land management during LUPA implementation. The following describes the types of tools BLM would consider to manage for climate change adaptation and resiliency.

- **Quantitative/Spatial Models:** Existing quantitative/spatial models, like the Climate Refugia and the Climate Velocity models described in Draft DRECP Appendix P, provide information that can assist in prioritizing management actions that influence climate change adaptation and resiliency. For example, the land acquisition criteria in the Compensation/Mitigation Implementation Section (Section II.3.7.1.5) factor in whether the land is "resistant to climate change and/or offering most climate refugia value". Quantitative models can provide information to support these decisions. Additionally, existing species distribution models were used to characterize the biological resources existing setting for focus species (see Chapter III.7 and Appendix Q of the DRECP Proposed LUPA and Final EIS), and similar modeling approaches could be applied to identify the modeled species distribution under projected climate scenarios (see Chornesky et al. 2015). Spatial models, like the terrestrial landscape intactness model developed for the DRECP (CBI 2013) as described in the Draft DRECP Monitoring and Adaptive Management Program, can be used to identify potential barriers to species and vegetation adaptation across the landscape.
- **Management-oriented Models:** As described in the Draft DRECP Monitoring and Adaptive Management Program, management-oriented models (also referred to as conceptual models) are widely used to "guide implementation of conservation actions and to address uncertainties in the actions". In Section II.3.6 of the DRECP Proposed LUPA and FEIS, these models are described as helping to "identify interactive effects of known or hypothesized important stressors and threats, effects of management actions (e.g., both positive and negative unintended consequences), and attendant uncertainties of model components and management outcomes". Existing management-oriented models were referenced in the Draft DRECP Monitoring and Adaptive Management Program, including conceptual models for the Aeolian sand community (Atkinson et al. 2004), desert tortoise (USFWS 2011), Mojave Fringe-toed lizard (DRECP ISA 2010), and several other relevant species and vegetation types (see BLM 2012 and BLM 2013).
- **Monitoring:** Monitoring is an essential tool for understanding uncertainties associated with climate change projections and ecological responses to changing climate conditions. As described under Land Use Plan Monitoring in the DRECP Proposed LUPA Monitoring and Adaptive Management Program (Section II.3.6.2.2), BLM will conduct both implementation monitoring and effectiveness

monitoring. Implementation monitoring is the "process of tracking and documenting the implementation, or progress toward implementation, of land use plan decisions. Effectiveness monitoring is the "process of collecting data and information as the plan is being implemented in order to determine whether or not desired outcomes are being met or whether progress is being made toward meeting them." As stated in the Adaptive Management Framework for the DRECP Proposed LUPA (Section II.3.6.2.3), "adaptive management, in concert with effectiveness monitoring, allows the DRECP LUPA to remain dynamic over time and responsive to changing conditions."

Effectiveness monitoring, as a tool for climate adaptation and resiliency, could occur at multiple scales. Effectiveness monitoring at the landscape-level would be designed to detect potential large-scale changes, such as alterations of ecosystem processes, shifts in vegetation distribution, and the integrity of habitat linkages. Effectiveness monitoring at the vegetation-level would be designed to detect changes in ecological communities, such as changes in species composition, invasive species, predator-prey populations, and other habitat functions. Effectiveness monitoring at the species-level would be designed to measure how individual species or guilds of species are responding to changing climate conditions.

P.4 LITERATURE CITED

Anacker, B. L., M. Gogol-Prokurat, K. Leidholm, and S. Schoenig. 2013. Climate change vulnerability assessment of rare plants in California. Madroño, 60(3), 193-210.

Allen, R.J. 2012. Climate change scenarios in Southern California. Presentation at University of California Riverside's Center for Conservation Biology and University of California Cooperative Extension's Climate Change Workshop. May 22, 2012, University of California Riverside, Palm Desert, California.

Araújo, M.B. 2009. Climate change and Spatial Conservation Planning. In Spatial Conservation Prioritization: quantitative methods and computational tools (eds. A. Moilanen, H. Possingham, K. Wilson). Oxford University Press.

Atkinson, A.J., KP.C. Trenham, R.N. Fisher, S.A. Hathaway, B.S. Johnson, S.G. Torres, and Y.C. Moore. 2004. *Designing Monitoring Programs in an Adaptive Management Context for Regional Multiple Species Conservation Plans.* Prepared by U.S. Geological Survey, Western Ecological Research Center, in partnership with California Department of Fish and Game and U.S. Fish and Wildlife Service.

Barrows, C. W., J. Hoines, K.D. Fleming, M.S. Vamstad, M. Murphy-Mariscal, K. Lalumiere, and M. Harding. 2014. Designing a sustainable monitoring framework for assessing impacts of climate change at Joshua Tree National Park, USA. Biodiversity and Conservation, 23(13), 3263-3285.

Beaumont, L., A. Pitman, S. Perkins, N. Zimmermann, N. Yoccoz, and W. Thuiller. 2011. Impacts of climate change on the world's most exceptional ecoregions. PNAS. 108(6): 2306–2311.

Beier, P., and B. Brost. 2010. "Use of Land Facets to Plan for Climate Change: Conserving the Arenas, not the Actors." *Conservation Biology* 24(3):701–710.

Bell, J. L., L. C. Sloan, and M. A. Snyder. 2004. Regional changes in extreme climatic events: A future climate scenario. Journal of Climate 17:81-87.

Berg, M., E. Kiers, G. Driessen, M. van der Heijden, B. Kooi, F. Kuenen, M. Liefting, H. Verhoef, and J. Ellers. 2009. Adapt or disperse: understanding species persistence in a changing world. Glob. Chg. Biol. doi: 10.1111/j.1365–2486.2009.02014x.

BLM (Bureau of Land Management). 2012. Sonoran Desert Rapid Ecoregional Assessment Report. May. Prepared for BLM by Dynamac Corporation and Conservation Biology Institute. http://www.blm.gov/style/medialib/blm/wo/Communications_Directorate/public_affairs/landscape_approach/documents1.Par.39003.File.dat/SOD_1_Final_Ch_1_2_and_3.pdf.

BLM. 2013. Mojave Basin and Range Rapid Ecoregional Assessment, Final Report. June. Prepared for BLM by NatureServe. http://www.blm.gov/style/medialib/blm/wo/Communications_Directorate/public_affairs/landscape_approach/documents1.Par.99875.File.dat/MBR_1_ReportBody.pdf.

Bowers, J.E., and R.M. Turner. 2001. "Dieback and Episodic Mortality of *Cercidium microphyllum* (Foothill Paloverde), a Dominant Sonoran Desert Tree." *Journal of the Torrey Botanical Society* 128(2):128–140.

Cal/EPA (California Environmental Protection Agency). 2013. Office of Environmental Health Hazard Assessment. Indicators of Climate Change in California. August 2013.

Cayan, D.R., E.P. Maurer, M.D. Dettinger, M. Tyree, and K. Hayhoe. 2008. "Climate Change Scenarios for the California Region." *Climatic Change* 87(Supplement 1):S21–S42.

CBI (Conservation Biology Institute). 2013. "Current Terrestrial Landscape Intactness (1km), DRECP." Final Draft v15a. http://databasin.org/datasets.

CDFG (California Department of Fish and Game). 2012. 2012 *Vegetation Map in Support of the Desert Renewable Energy Conservation Plan*. Interim Report (1.1). Vegetation Classification and Mapping Program for the Desert Renewable Energy Conservation Plan and California Energy Commission. June 2012. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=47996&inline=1.

Chen, I.C., J. Hill, R. Ohlemuller, D. Roy, and C. Thomas. 2011. Rapid range shifts of species associated with high levels of climate warming. Science. 333: 1024–1026.

Coe, S.J., D.M. Finch, M.M. Friggens. 2012. An assessment of climate change and the vulnerability of wildlife in the Sky Islands of the Southwest. Gen. Tech. Rep. RMRS-GTR-273. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 208 p.

Comer, P.J., B. Young, K. Schulz, G. Kittel, B. Unnasch, D. Braun, G. Hammerson, L. Smart, H. Hamilton, S. Auer, R. Smyth, and J. Hak.. 2012. Climate Change Vulnerability and Adaptation Strategies for Natural Communities: Piloting methods in the Mojave and Sonoran deserts. Report to the U.S. Fish and Wildlife Service. NatureServe, Arlington, VA.

Deutsch, C., J. Tewksbury, R. Huey, K. Sheldon, C. Ghalambor, D. Haak, and P. Martin. 2008. Impacts of climate warming on terrestrial ectotherms across latitude. PNAS. 105(18) 6668–6672.

DRECP ISA (Desert Renewable Energy Conservation Plan Independent Science Advisors). 2010. *Recommendations of the DRECP Independent Science Advisors for the California Desert Renewable Energy Conservation Plan.* DRECP-1000-2010-008-F. Prepared for the Renewable Energy Action Team. October 2010.

Elith, J., J.R. Leathwick. 2009. Species Distribution Models: Ecological Explanation and Prediction Across Space and Time Annu. Rev. Ecol. Evol. Syst. 2009. 40:677–97

EPA (U.S. Environmental Protection Agency). 2009. A framework for categorizing the relative vulnerability of threatened and endangered species to climate change. National Center for Environmental Assessment, Washington, DC; EPA/600/R-09/011. Available from the National Technical Information Service, Springfield, VA. http://www.epa.gov/ncea.

Epps, C.W., D.R. McCullough, J.D. Wehausen, V.C. Bleich, J.L. Rechel. 2004. Effects of Climate Change on Population Persistence of Desert-Dwelling Mountain Sheep in California. Conservation Biology. Vol. 18, No. 1, 102-113.

Esque, T.C., Nussear, K.E., Inman R.D., Matocq, M.D, Weisberg P.J., Dilts, T.E., Leitner, P. 2013. Habitat Modeling, Landscape Genetics, and Habitat Connectivity for the Mohave Ground Squirrel to Guide Renewable Energy Development. California Energy Commission. Publication number: CEC-500-2014-003.

Euskirchen, E., A. McGuire, F. Chapin, S. Yi, and C. Thompson. 2009. Changes in vegetation in northern Alaska under scenarios of climate change, 2003–2100: implications for climate feedbacks. Ecol. Apps. 19(4): 1022–1043.

Franco, A., J. Hill, C. Kitschke, Y. Collingham, D. Roy, R. Fox, B. Huntley, and C. Thomas. 2006. Impacts of climate warming and habitat loss on extinctions at species' low-latitude range boundaries. Global Chg. Biol. 12: 1545–1553.

Franklin, J. F.W. Davis, M. Ikegami, A.D. Syphard, L.E. Flint, A.L. Flint, and L. Hannah. 2013. Modeling plant species distributions under future climates: how fine scale do climate projections need to be? Global Change Biology, 19, 473-483.

Galbraith, H., D. Spooner, and C. Vaughn. 2010. Synergistic effects of regional climate patterns and local water management on freshwater mussel communities. Biol. Cons. 143: 1175–1183.

Gardali, T., N.E. Seavy, R.T. DiGaudio, L.A.Comrack. 2012. A climate change vulnerability sssessment of California's at-risk birds. PLoS ONE 7(3): e29507. doi:10.1371/journal.pone.0029507

Glick, P., B.A. Stein, and N.A. Edelson (eds.). 2011. *Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment*. National Wildlife Federation, Washington, DC. 168 pp.

Groom, M.J., G.K. Meffe, and C.R. Carroll. 2006. *Principles of Conservation Biology*. 3rd edition. Sunderland, Massachusetts: Sinauer Associates Inc.

Guida, R.J. 2011. Climate and vegetation change in the Newberry mountains, Southern Clark County, Nevada. *UNLV Theses/Dissertations/Professional Papers/Capstones.* Paper 1232. 120pp.

Inman, R.D., T.C. Esque, K.E. Nussear, P. Leitner, M. Matocq, P. Weisberg, T. Dilts, and A. Vandergast. 2013. "Is There Room for All of Us? Renewable Energy and *Xerospermophilus mohavensis*." *Endangered Species Research* 20:1–18. doi: 10.3354/esr00487.

Kelly, A.E. and M.L. Goulden. 2008. Rapid shifts in plant distribution with recent climate change. Proc. Natl. Acad. Sci. U.S.A. 105, 11823–11826.

Klausmeyer, K.R., M.R. Shaw, J.B. MacKenzie, and D.R. Cameron. 2011. Landscape-scale indicators of biodiversity's vulnerability to climate change. Ecosphere, 2(8), art 88.

LaDochy, S., R. Medina, and W. Patzert. 2007. Recent California climate variability: spatial and temporal patterns in temperature trends. Clim. Res. 33: 159–169.

Leslie, D.M., Jr., and C.L. Douglas. 1979. "Desert Bighorn Sheep of the River Mountains, Nevada." Supplement to *The Journal of Wildlife Management* 43(2), 1–55. Wildlife Monographs: The Wildlife Society.

Margules, C.R. and R.L. Pressey. 2000. "Systematic Conservation Planning." *Nature* 405: May 11, 2000.

McKechnie, A., and B. Wolf. 2010. Climate change increases the likelihood of catastrophic avian mortality events during extreme heat waves. Biol. Lett. 6: 253–256.

McKelvey, K.S., J.P. Copeland, M.K. Schwartz, J.S. Littell, K.B. Aubry, J.R. Squires, S.A. Parks, M.M. Elsner, and G.S. Mauger. 2011. Climate change predicted to shift wolverine distributions, connectivity, and dispersal corridors. Ecol. Apps. 21(8): 2882–2897.

Moyle, P.B., J.D. Kiernan, P.K. Crain, and R.M. Quiñones. 2012. Projected Effects of Future Climates on Freshwater Fishes of California. California Energy Commission. Publication number: CEC-500-2012-028.

Noss, R.F., M. O'Connell, and D.D. Murphy. 1997. The Science of Conservation Planning: Habitat Conservation Under the Endangered Species Act. Washington, D.C., and Covelo, California: Island Press.

Notaro, M., A. Mauss, and J.W. Williams. 2012. "Projected Vegetation Changes for the American Southwest: Combined Dynamic Modeling and Bioclimatic-Envelope Approach." *Ecological Applications* 22:1365–1388.

Parmesan, C. and J. Matthews. 2006. Biological impacts of climate change. *In* M.J. Groom, G.K. Meffe and C.R. Carroll, 3rd edition), *Principles of Conservation Biology* (pp. 333-374). Sinauer Associates, Inc.,

Penrod, K., P. Beier, E. Garding, and C. Cabañero. 2012. *A Linkage Network for the California Deserts*. Produced for the Bureau of Land Management and the Wildlands Conservancy. Fair Oaks, California, and Flagstaff, Arizona: Science and Collaboration for Connected Wildlands and Northern Arizona University.

Rogers, L.A., and D.E. Schindler. 2011. Scale and the detection of climatic influences on the productivity of salmon populations. Global Change Biology. 17: 2546–2558.

Sinervo, B., F. Mendez-de-la-Cruz, D. Miles, B. Heulin, E. Bastiaans, M. Villagran-Santa Cruz, R. Lara-Resendiz, N. Martinez-Mendez, M. Calderon-Espinosa, R. Meza-Lazaro, H. Gadsden, L. Avila, M. Morando, I. de la Riva, P. Sepulveda, C. Rocha, N. Ibarguengoytia, C. Puntriano, M. Massot, V. Lepetz, T. Oksanen, D. Chapple, A. Bauer, W. Branch, J. Clobert, and J. Sites. 2010. Erosion of lizard diversity by climate and altered thermal niches. Science. 328: 894–899.

Snyder, M.A., L.C. Sloan, and J.L. Bell. 2004. Modeled regional climate change in the hydrologic regions of California: A CO_2 sensitivity study. Journal of the American Water Resources Association 40:591-601.

Snyder, M.A. and L.C. Sloan. 2005. Transient future climate over the western United States using a regional climate model. Earth Interactions 9: Article No. 11.

Soulé, M. 1985. "What is Conservation Biology?" BioScience 35:727–734.

Soulé, M., ed. 1987. Viable Populations for Conservation. Cambridge: Cambridge University Press.

Stahlschmidt, Z.R., D.F. DeNardo, J.N. Holland, B.P. Kotler, and M. Kruse-Peeples. 2011. Tolerance mechanisms in North American deserts: Biological and societal approaches to climate change. Journal of Arid Environments 75(2011):681-687.

Stralberg, D., D. Jongsomjit, C.A. Howell, M.A. Snyder, J.D. Alexander, J.A. Wiens, T.L. Root. 2009. Re-Shuffling of Species with Climate Disruption: A No-Analog Future for California Birds? PLOS ONE 4(9): e6825. DOI:10.1371/journal.pone.0006825.

Turnage, W.V., and A.L. Hinckley. 1938. "Freezing Weather in Relation to Plant Distribution in the Sonoran Desert." *Ecological Monographs* 8(4):529–550.

USFWS (U.S. Fish and Wildlife Service). 2011. *Revised Recovery Plan for the Mojave Population of the Desert Tortoise* (Gopherus agassizii). May 6, 2011. Sacramento, California: USFWS, Region 8.

Weiss, J.L., and J.T. Overpeck. 2005. "Is the Sonoran Desert Losing Its Cool?" *Global Change Biology* 11(12):2065–2077.

Wiens, J.A., D. Stralberg, D. Jongsomjlt, C.A. Howell, and M.A. Snyder. 2009. Niches, models, and climate change: Assessing the assumptions and uncertainties. Proceedings of the National Academy of Sciences of the United States of America, v. 106, suppl. 2, 19729-19736.

Wright, A.N., R.J. Hijmans, M.W. Schwartz, and H.B. Shaffer. 2013. "California Amphibian and Reptile Species of Future Concern: Conservation and Climate Change." *Final Report to the California Department of Fish and Wildlife Nongame Wildlife Program.Task12, Contract no. P0685904.*

INTENTIONALLY LEFT BLANK