SHRUBLAND AND GRASSLAND HABITATS

Climate Change Vulnerability and Adaptation Strategies for Northwestern California

Shrubland and Grassland Habitat Descriptions

This summary includes information about shrubland and grassland habitats considered within the project area of the Northern California Climate Adaptation Project, which includes the Klamath, Six Rivers, Mendocino, and Shasta-Trinity National Forests as well as public lands managed by the Bureau of Land Management, including Arcata, Redding, and portions of the Ukiah field offices.

The following shrubland and grassland habitat types are considered in this summary:

Mixed Grasslands

Mixed grasslands are generally dominated by herbaceous vegetation comprised of both annual and perennial grasses and forbs. Grassland types considered in this assessment include interior or valley grasslands (found in the northern Central Valley and up to 2,300 ft on coastal hills and foothills), coastal prairie grasslands (found on coastal terraces influenced by summer fog), and serpentine grasslands (occur as habitat islands on ultramafic soils).

Chaparral Shrublands

Chaparral habitats are dominated by sclerophyllous ("hard-leaved") evergreen shrubs and small trees that are well-adapted to fire and drought, and can occur on both serpentine (ultramafic) and non-serpentine soils. Both montane chaparral (elevation 3,000–9,000 feet) and mixed chaparral (elevations below 5,000 feet) communities are found in northwestern California, often occupying drier sites and/or areas with shallow soils or recently disturbed areas.

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Alpine Grasslands/Shrublands

Alpine grasslands and shrublands occur above the treeline or in scattered openings within subalpine forests of the Klamath Mountains and southern Cascades. Plant communities are typically dominated by perennial herbaceous species (e.g., cushion plants, tufted or rhizomatous graminoids), and in some areas may include dwarf or low prostrate shrubs. Vegetation composition is strongly influenced by topography, substrate, and the harsh conditions typical of high-elevation sites.

Shrubland and grassland habitats in northwestern California have already experienced habitat loss and degradation due to land-use conversion, habitat fragmentation, and shifts in species composition following the spread of invasive plants and loss of historical disturbance regimes.

Key Climate Vulnerabilities

Shrubland and Grassland Habitats

Shrubland and grassland habitats in northwestern California are primarily sensitive to changes in factors that influence moisture availability (e.g., precipitation, drought) and successional dynamics (e.g., wildfire). These changes impact plant survival, growth, and recruitment, altering community composition, functional group dominance, and habitat distribution. Although grassland and shrubland habitats are widespread, particularly at lower and moderate elevations, many areas have been degraded by land-use change and invasive species that reduce their ability to cope with climate stressors and extreme events. However, intact native-dominated habitats are characterized by disturbance-adapted species, supporting relatively rapid recovery and the potential for adaptive responses to climate change.

Vulnerability Rankings for Shrubland and Grassland Habitats

Sensitivity & Exposure

Potential impacts of projected climate changes on shrubland and grassland habitats in northwestern California include:

- Altered patterns of survival and recruitment in native species, resulting in shifts in functional group dominance
- Increased dominance of exotic species, especially in burned areas; these, in turn, drive further increases in wildfire
- Increased plant mortality due to drier conditions, particularly where invasive species increase competition for soil moisture
- Type conversion of chaparral and native-dominated grasslands to non-native annual grasslands due to more frequent fires
- Shifts in plant phenology, leading to a mismatch with pollinator migration and life cycles that can impact species recruitment and community diversity
- Increased length of the growing season at high altitudes, contributing to the displacement of alpine specialists by lower-elevation species (including invasive species)

Projected Trends

Air temperature	▲
Precipitation	●
Soil moisture	▼
Drought	▲▲
Heat waves	▲
Wildfire	▲▲

Non-climate stressors may interact with climate stressors and disturbance regimes:

- *Invasive species* enhance competition for soil moisture, displacing native species and impacting habitat structure, composition, and function; they also drive further changes in fire frequency
- *Roads, highways, and trails* spread invasive plants and deposit nitrogen that promotes their establishment and growth; they also fragment habitats and increase the risk of human ignitions
- *Fire exclusion* and *fuel reduction activities* physically alter habitat structure and species composition, reducing heterogeneity and potentially increasing fire severity

Adaptive Capacity

Intrinsic (i.e., inherent characteristics) and extrinsic (i.e., management potential) factors that enhance or undermine the ability of shrubland and grassland habitats to cope with climate impacts include:

Intrinsic factors:

- ▲ Extensive distribution within the region
- ▲ High physical/topographical and species diversity
- ▲ Generally well-adapted to drought and fire
- ▲ Stress-tolerant traits in serpentine species likely increase resistance to climate stressors
- ▼ Degraded by land-use conversion and human activities (e.g., fuel treatments)
- ▼ Slow recovery from disturbance and little to no migration potential for alpine and serpentine species

Extrinsic factors:

- ▲ High public/societal value of alpine habitats due to recreation and cultural significance
- ▲ Provide critical ecosystem services (e.g., erosion control, carbon sequestration)
- ▲ Climate-informed management supported by traditional knowledge and scientific literature
- ▼ Low public/societal value of chaparral due to public perception of fire risk
- ▼ Limited opportunity to manage climate stressors at high elevations
- ▼ Difficult to generalize management recommendations across the landscape

Key Climate Vulnerabilities:

Shrubland- and Grassland-Associated Species

Changes in climate factors and disturbance regimes that impact habitat extent, quality, and connectivity are likely to impact species groups associated with shrubland and grassland habitats, including **native pollinators** and **migratory birds**. Critical impacts may include:

- Altered patterns of moisture availability and climate-driven changes in wildfire frequency and/or severity are likely to alter plant species composition and habitat distribution, impacting availability of nesting sites and food resources

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- Increased physiological stress and mortality due to wildfire, heat waves, and disease outbreaks
- Increased mortality, habitat loss and fragmentation, and degraded remnant habitats due to non-climate stressors (e.g., land-use conversion, pesticides/herbicides, invasive plants, grazing)

Factors that enhance or undermine adaptive capacity:

- ▲ Widespread and occupy many habitat types
- ▲ Diverse life history strategies, buffering against complete loss of the species groups
- ▲ High mobility allows response to environmental changes
- ▲ Highly valued for public appeal (birds) and ecosystem services provided (pollinators)
- ▼ Population declines occurring in many species due to multiple stressors
- ▼ Small and/or isolated populations more vulnerable to extirpation and have lower capacity for genetic adaptation to change
- ▼ Challenging to manage breeding, wintering, and stopover habitats for migratory species

Vulnerability Rankings for Shrubland- and Grassland-Associated Species

Native Pollinators → *Moderate Vulnerability*

Migratory Birds → *Moderate Vulnerability*

Understanding which components are driving overall vulnerability for a given habitat or species gives managers a better understanding of the actions that may be most effective at reducing climate change vulnerability. For instance, although all shrubland and grassland habitats and species received an overall vulnerability ranking of moderate, low adaptive capacity was an important factor driving vulnerability for alpine grasslands and shrublands while high sensitivity and exposure were important factors driving vulnerability for migratory waterfowl and songbirds. This suggests that managers may want to focus on actions that increase adaptive capacity for alpine grasslands and shrublands and reduce sensitivity and exposure for migratory waterfowl and songbirds.

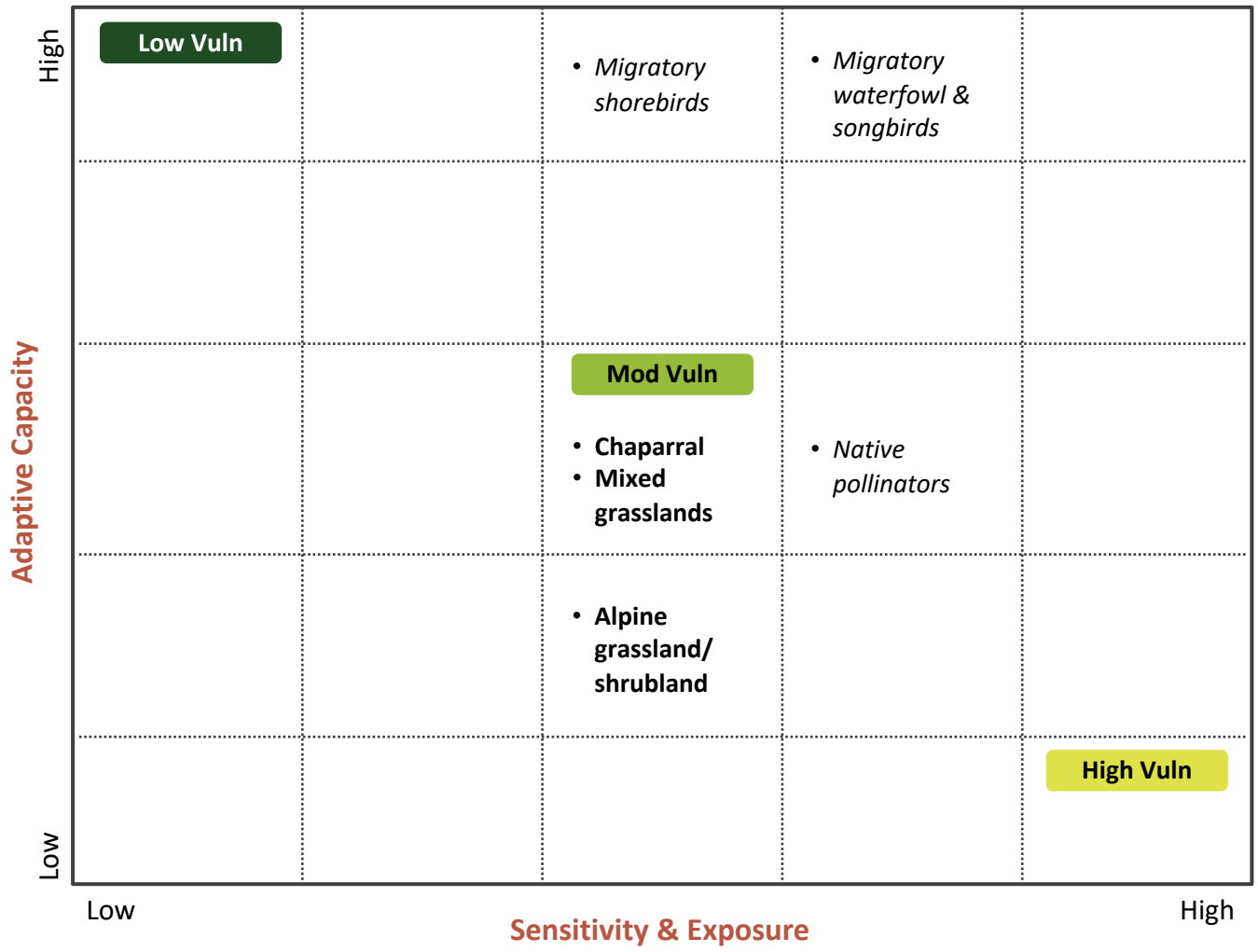


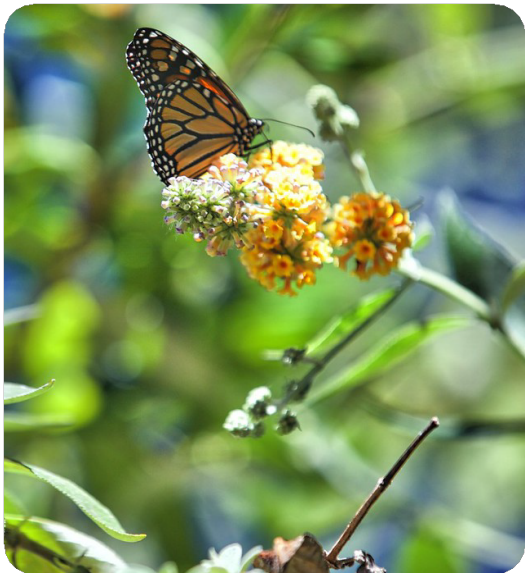
Figure 1. Sensitivity and exposure (impact) and adaptive capacity rankings plotted for northwestern California shrubland and grassland habitats and associated species. Habitats and species with high vulnerability to climate change (high impact/low adaptive capacity) are located in the lower right, while those with low vulnerability (low impact/high adaptive capacity) are in the upper left.

Climate Change Adaptation Strategies and Actions:

Shrubland and Grassland Habitats

Climate change adaptation refers to adjustments in natural or human systems in response to changing climate conditions.

Adaptation strategies attempt to reduce climate change vulnerability by ***reducing climate impacts (sensitivity and exposure)*** and/or ***increasing resilience (adaptive capacity)***.



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Adaptation Approaches

Climate change adaptation strategies are organized into three general management approaches: resistance/resilience, acceptance, and direct/response. Two additional approaches – knowledge and collaboration – describe adaptation strategies that support management efforts and may be precursors to implementing a strategy that falls under another approach (e.g., direct/response).

Resistance / Resilience

Focused on managing for persistence of existing ecosystems

Near- to mid-term planning horizon; management-intensive approach

Acceptance

Focused on accommodating change in response to novel conditions

Long-term planning horizon; no management action beyond observation

Direct / Response

Focused on actively facilitating change/ transformation in response to novel conditions

Long-term planning horizon; may be management-intensive

Knowledge

Focused on gathering information about climate impacts and/or the effectiveness of management actions through research and monitoring

Collaboration

Focused on coordinating efforts and/or building support and capacity across agencies, organizations, and stakeholder groups

Aim to identify and/or implement a balanced portfolio of adaptation approaches

Over time, the balance may need to shift towards approaches that allow or facilitate change and transformation.

Adaptation Strategies for Shrubland and Grassland Habitats

The table below summarizes management goals and associated adaptation strategies that have been identified for northwestern California shrubland and grassland habitats and associated species.

GOAL 1. REDUCE THE IMPACT OF NON-CLIMATE STRESSORS
1.1 Prevent the introduction and establishment of invasive species and remove existing populations
1.2 Manage herbivory to promote regeneration of desired species
1.3 Reduce competition with encroaching woody vegetation for moisture, nutrients, and light
GOAL 2. REDUCE THE RISK AND IMPACTS OF SEVERE DISTURBANCES/EXTREME EVENTS
2.1 Reduce the risk of anthropogenic ignitions in fire-prone areas
2.2 Utilize fuelbreaks to slow the spread of high-intensity fire
GOAL 3. SUSTAIN FUNDAMENTAL ECOLOGICAL FUNCTIONS AND PROCESSES
3.1 Restore the role of fire as an ecological process on the landscape
GOAL 4. ENHANCE HABITAT QUALITY AND AVAILABILITY FOR NATIVE POLLINATORS
4.1 Promote pollinator-friendly agricultural practices
4.2 Increase floral resource and host plant availability for native pollinators
GOAL 5. MAINTAIN AND ENHANCE SPECIES AND STRUCTURAL DIVERSITY
5.1 Increase seed collection and plant propagation of native species
GOAL 6. PROMOTE LANDSCAPE CONNECTIVITY
6.1 Maintain and/or create migration corridors for native plants and wildlife
GOAL 7. ALLOW OR FACILITATE SPECIES AND HABITAT ADJUSTMENTS TO BETTER ALIGN WITH CHANGING CLIMATE CONDITIONS
7.1 Allow realignment of significantly disrupted ecosystems to meet expected future conditions
7.2 Move at-risk species to locations that are expected to provide habitat
GOAL 8. IMPROVE UNDERSTANDING OF CLIMATE CHANGES AND IMPACTS THROUGH RESEARCH AND MONITORING
8.1 Increase understanding of current conditions and projected future changes in grasslands and shrublands
8.2 Increase understanding of current species ecology and projected future changes
GOAL 9. IMPROVE UNDERSTANDING ABOUT THE EFFECTIVENESS OF ADAPTATION ACTIONS THROUGH RESEARCH, MONITORING, AND EVALUATION
9.1 Evaluate the feasibility and/or effectiveness of potential management options
GOAL 10. INCREASE SUPPORT AND CAPACITY FOR HABITAT MANAGEMENT
10.1 Promote awareness of and appreciation for grassland and shrubland ecosystems and associated species

Reducing Vulnerabilities Through Adaptation Actions

The table below presents examples of adaptation actions associated with each management goal and strategy. Adaptation actions fall within the five adaptation approaches: Resistance/Resilience **(R)**, Acceptance **(A)**, Direct/Response **(D)**, Knowledge **(K)**, and Collaboration **(C)**. Adaptation strategies can reduce climate change vulnerability of a given habitat or species by addressing any or all of the components of vulnerability: reducing sensitivity, reducing exposure, and/or increasing adaptive capacity. Strategies are linked to whether they reduce climate impacts (sensitivity & exposure) or increase resilience (adaptive capacity).

GOAL 1. REDUCE THE IMPACT OF NON-CLIMATE STRESSORS

1.1 Prevent the introduction and establishment of invasive species and remove existing populations

Example adaptation actions:

- Remove non-native annual grasses and other invasive plant species using a variety of treatments (e.g., prescribed fire, mowing, hand pulling, herbicides) **(R)**
- Follow best management practices (e.g., inspection and decontamination procedures) to reduce the spread of invasive species during management and restoration activities **(R)**
- Build invasive species management into post-fire restoration activities (e.g., suppression repair, BAER) **(R)**
- Increase monitoring of known or potential invasive species to ensure early detection **(R/K)**

Vulnerabilities addressed:

Invasive plants

Air temperature *(expanding range of invasive plants)*

Precipitation and drought *(competition for soil moisture)*

Wildfire *(fuels that facilitate spread of fire)*

Fire suppression activities, roads/highways, recreation *(facilitates spread of invasive species)*

1.2 Manage herbivory to promote regeneration of desired species

Example adaptation actions:

- Adjust grazing timing, frequency, and intensity to promote vegetation recovery of perennial grasses and other desired vegetation **(R)**
- Use exclusion fencing in sensitive and/or degraded areas to reduce herbivory of regenerating perennial grasses and other desired species **(R)**

Vulnerabilities addressed:

Livestock grazing

Air temperature, precipitation, soil moisture, drought *(changes in productivity/phenology)*

GOAL 1. REDUCE THE IMPACT OF NON-CLIMATE STRESSORS *(CON'T)*

1.3 Reduce competition with encroaching woody vegetation for moisture, nutrients, and light

Example adaptation actions:

- Remove encroaching woody vegetation via mechanical thinning and/or hand removal **(R)**
- Develop community or citizen steward groups (similar to TREX Training Exchange) to treat areas of new conifer encroachment **(R/C)**

Vulnerabilities addressed:

Fire exclusion

Precipitation and drought *(competition for soil moisture)*

Management capacity *(shortage of trained workforce)*

GOAL 2. REDUCE THE RISK AND IMPACTS OF SEVERE DISTURBANCES/EXTREME EVENTS

2.1 Reduce the risk of anthropogenic ignitions in fire-prone areas

Example adaptation actions:

- Consider closing recreation areas or restricting permitted activities during red-flag warnings **(R)**
- Expand public education campaigns focused on the risk of roadside ignitions and the importance of creating defensible space **(R/C)**

Vulnerabilities addressed:

Wildfire

Roads/highways, recreation *(source of human ignitions)*

Residential development *(high fire risk within the wildland-urban interface)*

2.2 Utilize fuelbreaks to slow the spread of high-intensity fire

Example adaptation actions:

- Create and use roadside grazing corridors to reduce potential fuels (e.g., annual grasses) **(R)**
- Plant low-flammability native vegetation (e.g., tarweed) along roadsides to slow the spread of fire **(R)**
- Use low-intensity prescribed fire to create a buffer zone around sensitive areas **(R)**

Vulnerabilities addressed:

Wildfire

Roads/highways *(source of human ignitions)*

Invasive plants *(fuels that facilitate spread of fire)*

GOAL 3. SUSTAIN FUNDAMENTAL ECOLOGICAL FUNCTIONS AND PROCESSES

3.1 Restore the role of fire as an ecological process on the landscape

Example adaptation actions:

- Use prescribed burning to remove encroaching woody vegetation and increase vigor and recruitment in native grassland and shrubland plants **(R)**
- Partner with local tribes to share resources & expand the use of cultural burning & managed wildfire **(R/C)**

Vulnerabilities addressed:

Fire exclusion

Precipitation and drought *(competition for soil moisture from encroaching woody vegetation)*

Wildfire *(uncharacteristically frequent fires that can lead to type conversion)*

Invasive plants *(displacement of native species in the absence of fire)*

Management capacity *(loss of tribal stewardship, lack of capacity to scale up use of prescribed fire)*

GOAL 4. ENHANCE HABITAT QUALITY AND AVAILABILITY FOR NATIVE POLLINATORS

4.1 Promote pollinator-friendly agricultural practices

Example adaptation actions:

- Collaborate with farmers to reduce or eliminate the exposure of pollinators to pesticides **(R/C)**

Vulnerabilities addressed:

Agriculture, poisons *(use of pesticides exacerbating climate-driven population declines)*

4.2 Increase floral resource and host plant availability for native pollinators

Example adaptation actions:

- Install hedgerows along field edges, ditches, and rural roads in modified agricultural landscapes **(R)**
- Support and expand programs that encourage the creation of pollinator gardens in residential areas **(R)**
- Consider the availability of host plants and season-long food sources in the restoration planting mix **(R)**
- Experiment with planting pollinator forage and host plants in wetlands projected to dry out **(D)**

Vulnerabilities addressed:

Agriculture, residential development *(habitat loss and fragmentation)*

Air temperature, precipitation, soil moisture, drought *(changes in productivity/phenology)*

GOAL 5. MAINTAIN AND ENHANCE SPECIES AND STRUCTURAL DIVERSITY

5.1 Increase seed collection and plant propagation of native species

Example adaptation actions:

- Collect chaparral seeds to use for diversifying stands during post-fire planting efforts **(R)**
- Collect and store seed from serpentine species for use in restoration and planting programs **(R)**

Vulnerabilities addressed:

Wildfire *(native species declines due to uncharacteristically frequent fires)*

Habitat diversity *(declines in species and genetic diversity)*

GOAL 6. PROMOTE LANDSCAPE CONNECTIVITY

6.1 Maintain and/or create migration corridors for native plants and wildlife

Example adaptation actions:

- Map and characterize connectivity between natural areas for plant and animal migration **(K)**
- Protect land in priority connectivity/corridor areas via acquisition, realty actions, or land trades **(R)**

Vulnerabilities addressed:

Human land uses that contribute to habitat loss and fragmentation

Air temperature, precipitation, soil moisture *(changes in habitat suitability)*

Habitat continuity *(barriers to migration and dispersal)*

GOAL 7. ALLOW OR FACILITATE SPECIES AND HABITAT ADJUSTMENTS TO BETTER ALIGN WITH CHANGING CLIMATE CONDITIONS

7.1 Allow realignment of significantly disrupted ecosystems to meet expected future conditions

Example adaptation actions:

- Identify areas where post-fire type conversion should be allowed to occur without intervention **(A)**

Vulnerabilities addressed:

Wildfire *(post-fire shift to less sensitive plant communities)*

Management potential *(ability to effectively alleviate climate impacts for some areas/habitats)*

7.2 Move at-risk species to locations that are expected to provide habitat

Example adaptation actions:

- Consider assisted migration of serpentine species to new locations that are expected to remain or become suitable under future climate conditions **(D)**

Vulnerabilities addressed:

Air temperature, precipitation, soil moisture *(changes in habitat suitability)*

Population connectivity *(risk of extirpation for small, isolated populations unable to migrate due to discontinuous patches of suitable habitat)*

GOAL 8. IMPROVE UNDERSTANDING OF CLIMATE CHANGES AND IMPACTS THROUGH RESEARCH AND MONITORING

8.1 Increase understanding of current conditions and projected future changes in grasslands and shrublands

Example adaptation actions:

- Identify species at risk of extirpation (e.g., rare and/or specialized species) and whether others will be able to fulfill a similar functional role within the ecosystem **(A/K)**

Vulnerabilities addressed:

Functional diversity *(ability of species within the assemblage to provide critical habitat niches and/or ecosystem services)*

Management potential *(knowledge informing management decisions)*

GOAL 8. IMPROVE UNDERSTANDING OF CLIMATE CHANGES AND IMPACTS THROUGH RESEARCH AND MONITORING *(CON'T)*

8.2 Increase understanding of current species ecology and projected future changes

Example adaptation actions:

- Expand research on apiary and honeybee impacts on native pollinators **(K)**
- Expand research on native pollinator plant preferences and uses (e.g., specialists vs. generalists, nighttime vs. daytime pollinators) **(K)**
- Expand research on and monitoring of observed and projected phenological shifts in plants and native pollinators **(K)**

Vulnerabilities addressed:

Management potential *(knowledge informing management decisions)*

GOAL 9. IMPROVE UNDERSTANDING ABOUT THE EFFECTIVENESS OF ADAPTATION ACTIONS THROUGH RESEARCH, MONITORING, AND EVALUATION

9.1 Evaluate the feasibility and/or effectiveness of potential management options

Example adaptation actions:

- Increase research on and monitoring of the effects of prescribed fire timing and intensity on invasive species **(R/K)**

Vulnerabilities addressed:

Management potential *(knowledge informing management decisions)*

GOAL 10. INCREASE SUPPORT AND CAPACITY FOR HABITAT MANAGEMENT

10.1 Promote awareness of and appreciation for grassland and shrubland ecosystems and associated species

Example adaptation actions:

- Create outreach campaigns designed to increase recognition of chaparral as an important California ecosystem **(C)**
- Increase education and outreach on serpentine habitats and the endemic species they harbor **(C)**
- Expand public education and outreach on the importance of native pollinators and their habitat requirements **(C)**

Vulnerabilities addressed:

Public/societal value *(support for management)*

EcoAdapt™

All information within this brief is summarized from the source reports of the Northern California Climate Adaptation Project, available at https://tinyurl.com/NorCalAdaptation