

# Supporting Incorporation of Climate Change into Federal Plan Revisions for Northern California

May 3, 2022



**THE EVENT WILL START  
SHORTLY!**



# Supporting Incorporation of Climate Change into Federal Plan Revisions for Northern California

May 3, 2022





# GoToWebinar Orientation



Now viewing EcoAdapt Host's screen

Microphone Zoom: 55% Screenshot

Photo by Bob Winkler via Flickr (CC BY 2.0)

**Supporting  
Incorporation of  
Climate Change into  
Federal Plan  
Revisions for  
Northern California**

**May 3, 2022**

**Full Screen  
Raise Hand**

**Questions**

**Microphone &  
Speaker  
Options**

**THE EVENT WILL START  
SHORTLY!**

**EcoAdapt™**  
*Meeting the challenge of climate change*

**FOREST SERVICE  
U.S. DEPARTMENT OF AGRICULTURE**

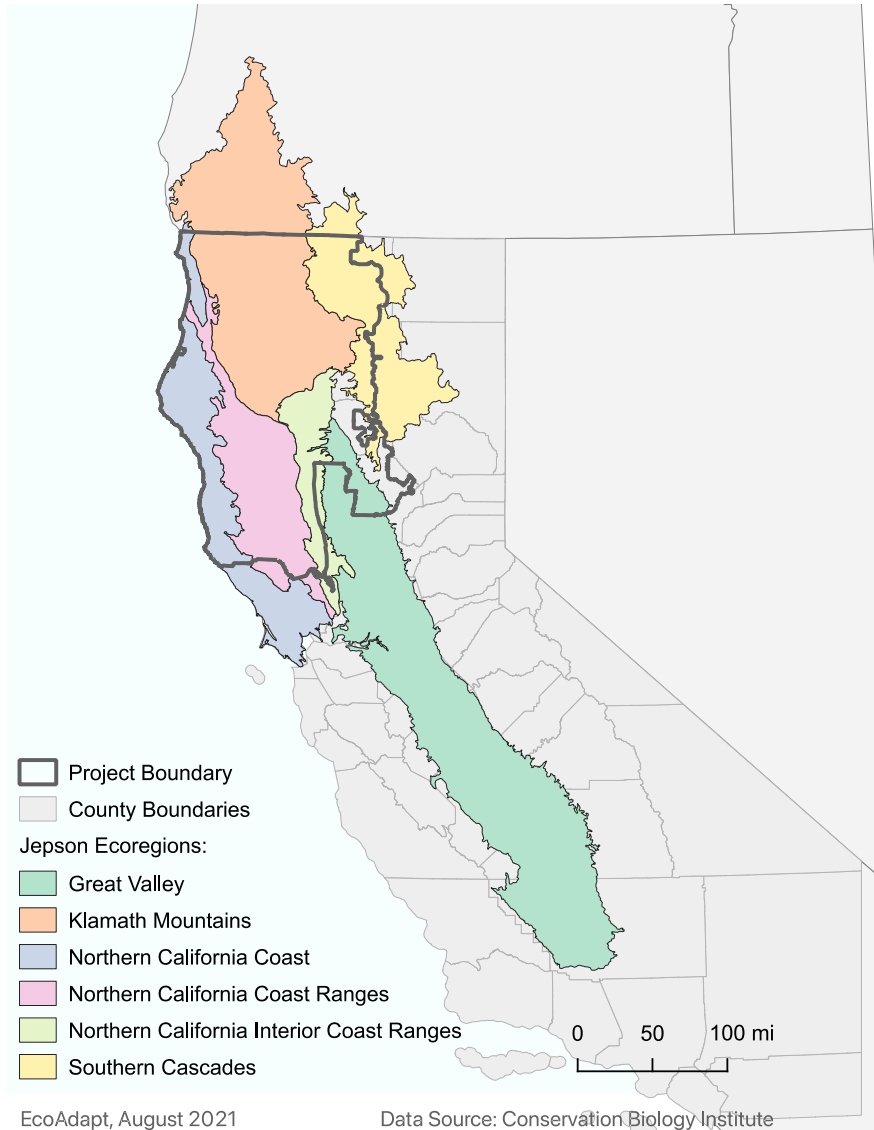
**U.S. DEPARTMENT OF THE INTERIOR  
BUREAU OF LAND MANAGEMENT**

**TEST: Tribal & Indigenous Climate  
Adaptation Series**  
Webinar ID# 154-999-283  
This session is being recorded.

**GoToWebinar**

Validation\_St: CHLA\_5906040.jp O2\_5906295.jpg  
ats.xlsx g

# Northern California Climate Adaptation Project



## Project Goals

- Improve understanding of how and why important Northern California resources may be vulnerable to changing climate conditions
- Identify adaptation actions that can be implemented to reduce vulnerabilities and/or increase overall resilience

# Northern California Climate Adaptation Project



Photo by Bob Wick/BLM via Flickr (CC BY 2.0)

- **Synthesis** of observed and projected future climatic changes
- **Vulnerability assessments** for focal habitats and species
- Stakeholder-developed **adaptation strategies and actions**
- **Supporting maps and climate data** on Data Basin
- A **network of practitioners** interested and engaged in adaptation



# Webinar Overview



## Welcome and Introduction

### Bureau of Land Management

- Climate Change Policy & Context (*Jim Weigand*)
- Application to BLM Planning Processes (*Katie Flahive*)

### U.S. Forest Service

- Climate Change Policy & Context (*Lara Buluc & Logan Graham*)
- Application to USFS Planning Processes (*Sarah Sawyer*)

### Northern California Climate Adaptation Project

- Project findings and available products





Photo by Peter Pearsall/USFWS via Flickr (Public Domain)



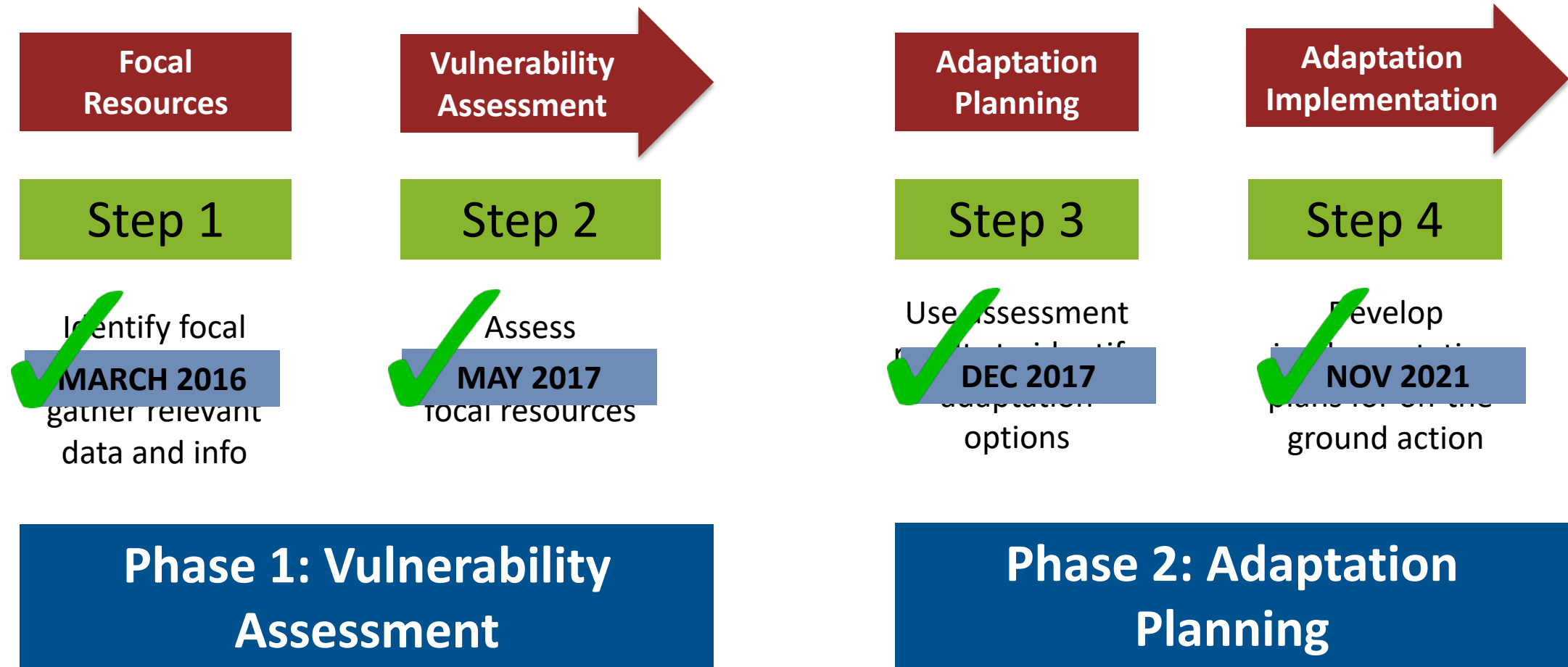
Photo by John Game via Flickr (CC BY 2.0)



# Vulnerability Assessments, Mapping, & Adaptation Strategies FOR NORTHWESTERN CALIFORNIA



# Project Timeline





# Project Findings



Photo by Redwood National and State Forests via Flickr (Public Domain)

- **Vulnerability Assessments**
- **Regional Climate Impacts**
- **Climatic Water Deficit Maps**
- **Adaptation Strategies & Actions**
- **Adaptation Implementation Plans**

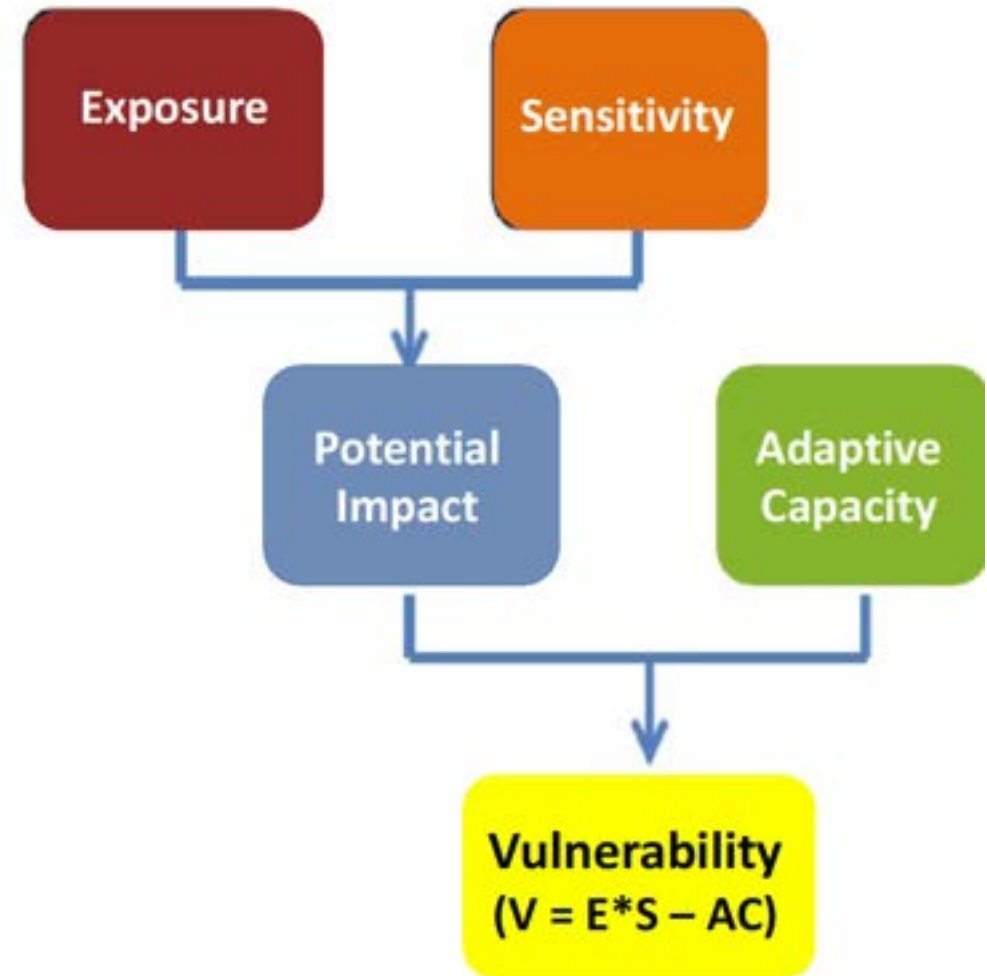
# Vulnerability Assessment



Purpose of a vulnerability assessment:

Identify ***which*** resources are most vulnerable and ***why***

- **Exposure**
- **Sensitivity**
- **Adaptive Capacity**





# Vulnerability Assessment



**EXPOSURE** is a measure of *how much change* in climate that a resource is likely to experience

## Factors considered:

- Direction and magnitude of change in climate stressors and disturbance regimes
- Degree of uncertainty associated with projected changes



Photo by BLM/Bob Wick (Public Domain)

# Vulnerability Assessment



Photo by USFS/Mike McMillan (Public Domain)

**SENSITIVITY** is a measure of whether and how a resource is likely to be affected by a given change in climate factors

## **Factors affecting sensitivity:**

- Climate drivers
- Disturbance regimes
- Non-climate stressors



# Vulnerability Assessment



**ADAPTIVE CAPACITY** is a measure of a resource's ability to accommodate or cope with climate change impacts with minimal disruption

## Factors affecting adaptive capacity:

- Extent & integrity
- Connectivity
- Resistance & recovery
- Diversity
- Public, societal, and cultural value
- Management potential



Photo by USFWS via Flickr (Public Domain)

# Climate Change Vulnerability: *Late-Successional-Dependent Species*



**Moderate-High Vulnerability**

*Moderate Confidence*

## Exposure



**Moderate Exposure**

*Low Confidence*

- ↑ Air temperature
- ↑ Heat waves
- ↑↓ Precipitation amount/timing
- ↑ Drought
- ↓ Snowpack
- ← Timing of snowmelt/runoff
- ↑ Storms
- ↑ Wildfire

## Sensitivity



**Moderate-High Sensitivity**

*High Confidence*

- Decreased survival and recruitment
- Altered prey availability and interspecific competition for food/habitat resources
- Changes in habitat structure and availability of critical habitat features
- Reduced habitat extent and connectivity
- Shifts in species distribution
- *Non-climate stressors*: Fire exclusion, timber harvest, roads, poisons

## Adaptive Capacity



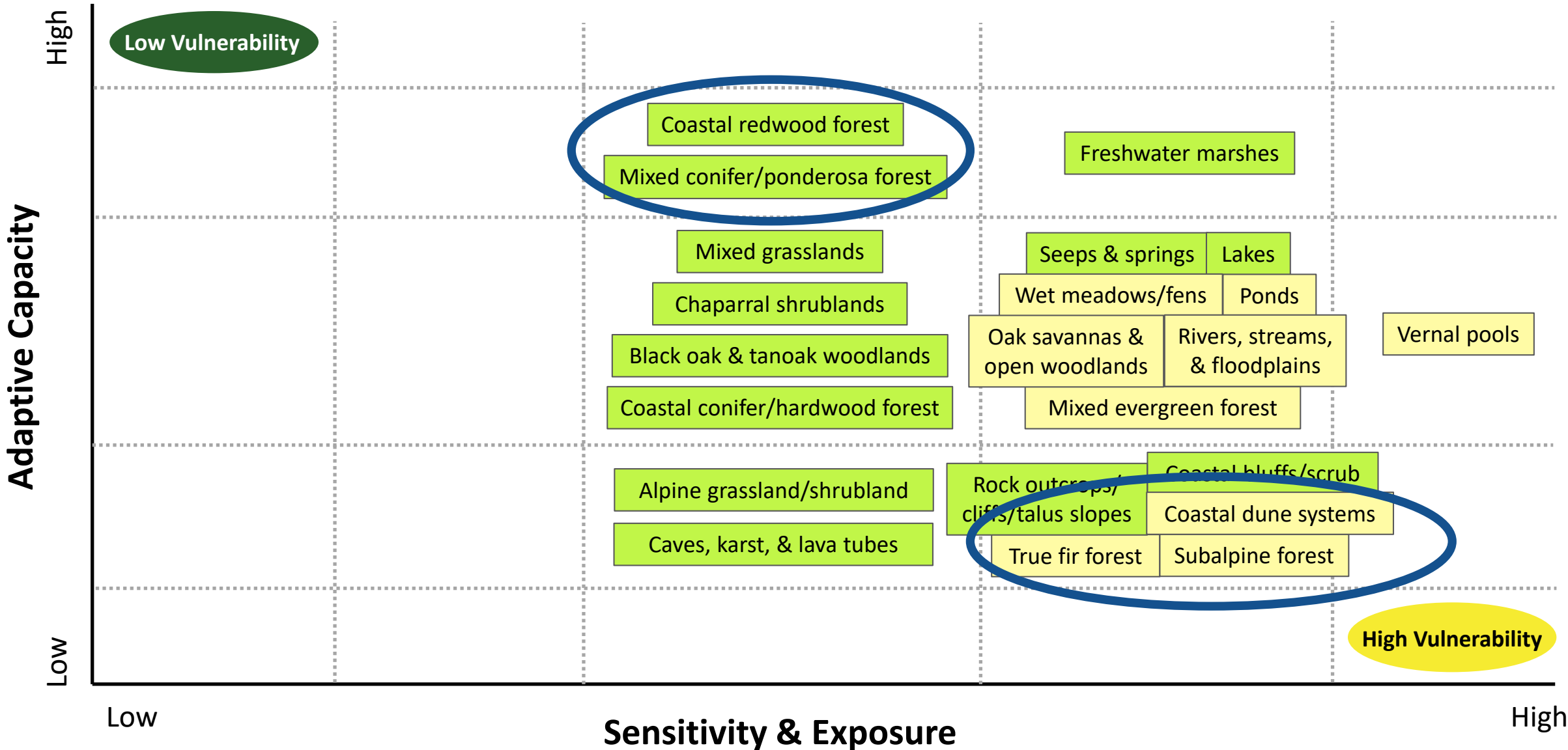
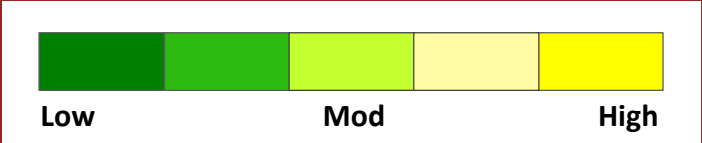
**Low-Moderate Adaptive Capacity**

*High Confidence*

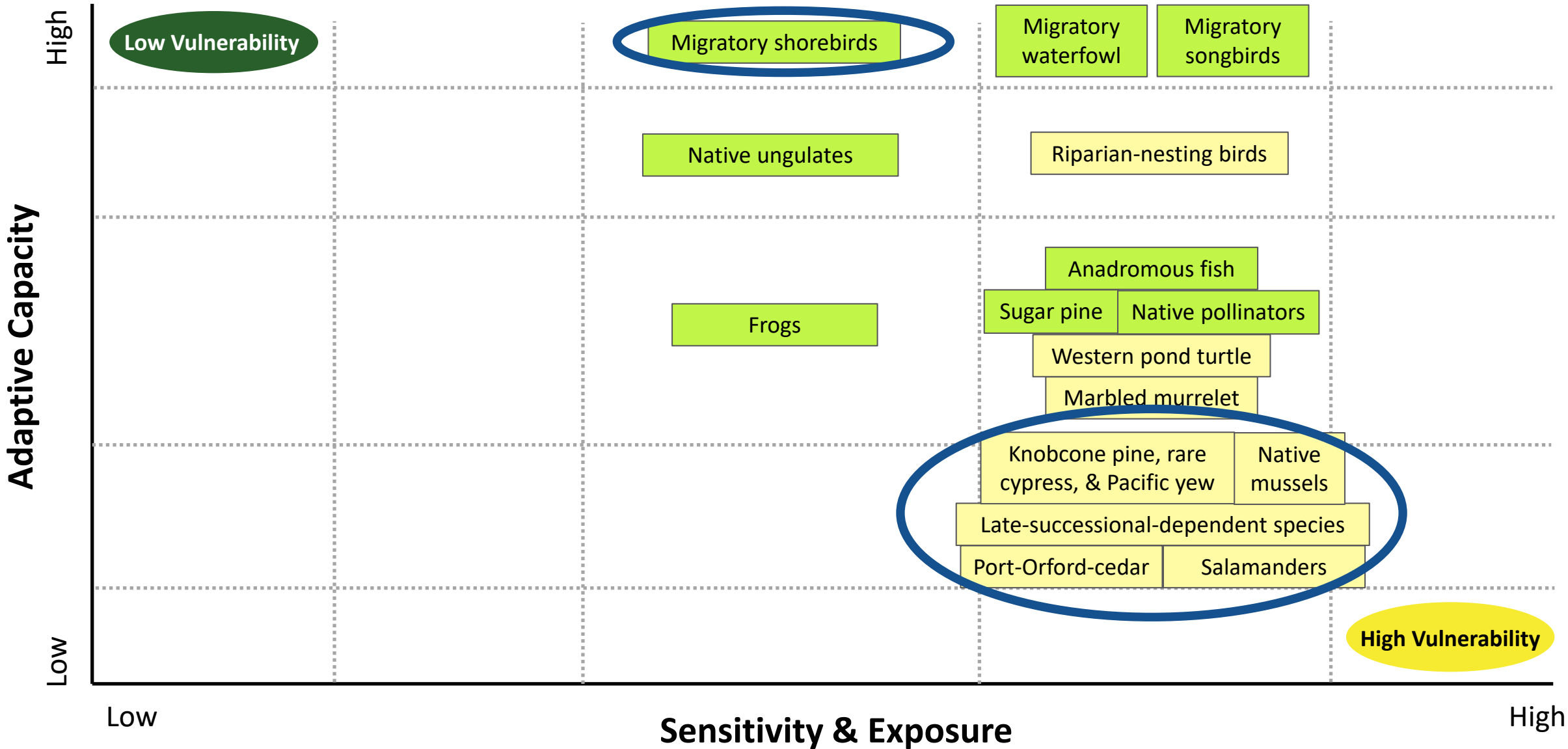
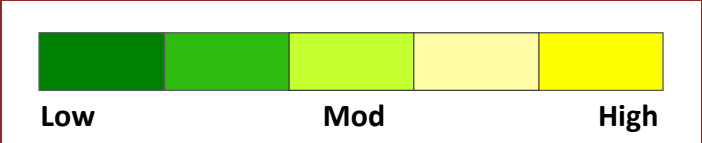
- ▲ Behavioral plasticity
- ▲ Some regulatory and legislative support for species management
- ▼ Declining regional populations
- ▼ Small, isolated populations vulnerable to extirpation or genetic bottlenecks
- ▼ Recovery limited by low reproductive potential & reliance on late-seral stand conditions



# Vulnerability Results: *Habitats*



# Vulnerability Results: *Species*





# Vulnerability Assessment Trends



## Climate Stressors

- Precip/soil moisture
- Drought

## Disturbance Regimes

- Wildfire
- Disease

## Non-Climate Stressors

- Fire suppression
- Timber harvest
- Pollutions & poisons
- Dams & water diversions
- Roads, highways, & trails

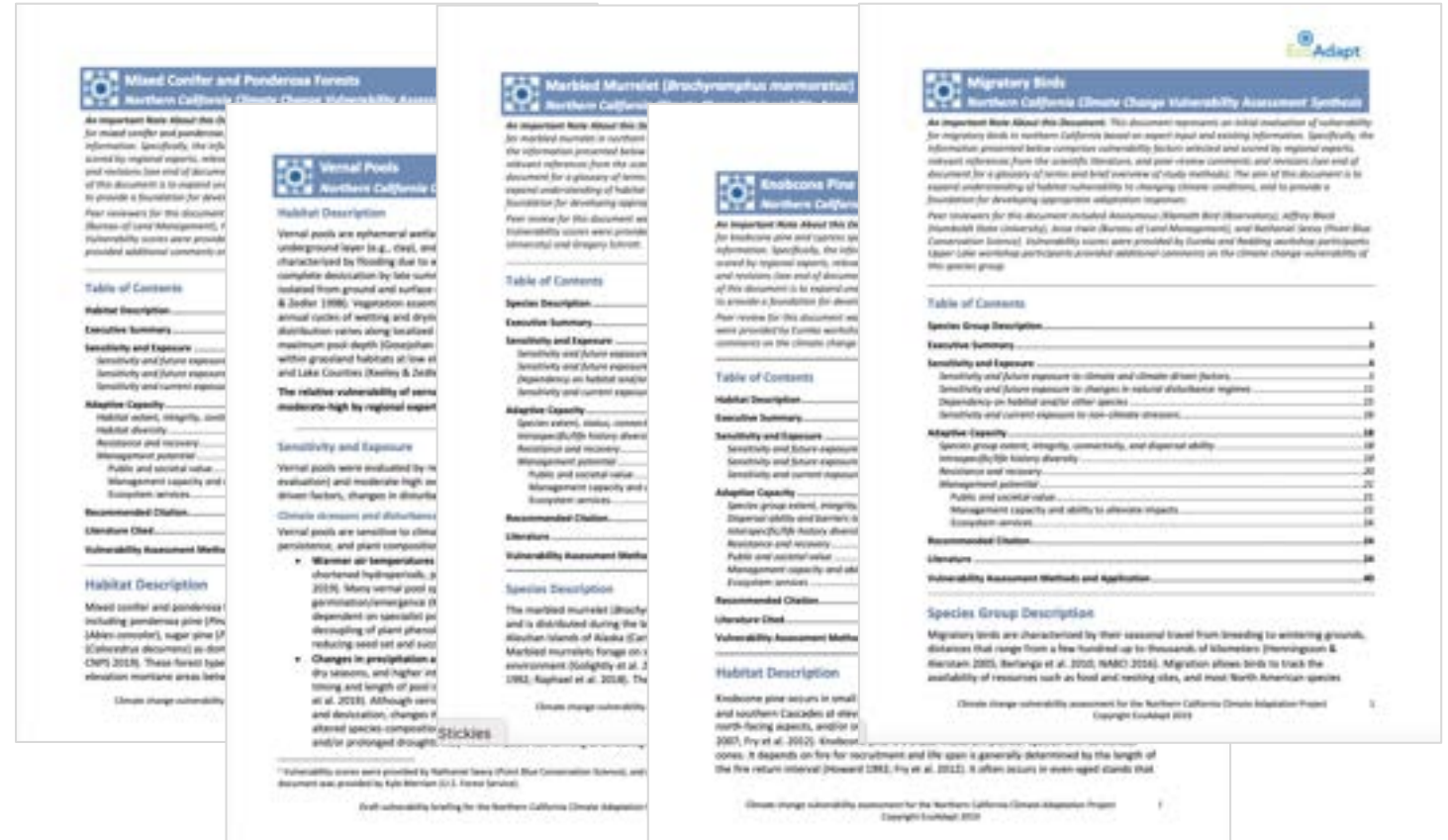


## Adaptive Capacity Factors

- ▲ High physical and topographical diversity
- ▲ Large areas of undeveloped/roadless land increase connectivity
- ▼ Many habitats & populations degraded
- ▼ Past management activities
- ▼ Low to mod management capacity & ability



- Product:** Vulnerability assessment syntheses for 33 focal resources






# Regional Climate Impacts



**Northern California Climate Adaptation Project:**  
**Overview of Climate Trends and Projections**

**Table of Contents**

- Introduction ..... 2
- Trends and Projections for Climate and Climate-Driven Factors ..... 4
  - Air Temperature ..... 4
  - Water Temperature ..... 6
  - Precipitation ..... 7
  - Climatic Water Deficit & Soil Moisture ..... 10
  - Snowpack ..... 16
  - Timing of Snowmelt and Runoff ..... 18
  - Streamflow ..... 18
  - Coastal Fog ..... 19
  - Sea Level Rise ..... 19
- Trends and Projections for Extreme Events and Natural Disturbance Regimes ..... 21
  - Heat Waves ..... 21
  - Extreme Precipitation, Storms, and Flooding ..... 21
  - Drought ..... 22
  - Wildfire ..... 22
- Literature Cited ..... 24



**Product: Climate impacts report summarizing trends & projections**

Table 1. Summary of trend direction and projected future changes for climate and climate-driven factors, extreme events, and major natural disturbance regimes within the Northern California Climate Adaptation Project study area.

Variable	Trend	Projected Future Changes
<b>Climate and climate-driven factors</b>		
Air temperature	↑	• 2.2–6.1°C (4.0–11.0°F) increase in annual mean
Water temperature	↑	• 0.4–0.8°C (0.8–1.4°F) increase in August stream 2080s
Precipitation	↑↓	• -23% to +38% change in mean annual precipitation • Shorter, wetter winters and longer, drier summers • Increased interannual variability
CWD & Soil moisture	↑↓	• 4–43% increase in mean annual climatic water deficit • Reduced soil moisture due to enhanced evaporation
Snowpack & Snowmelt	↑↓	• 61–100% decrease in April 1 snow water equivalent • 5–15-day shift towards earlier timing of snowmelt
Streamflow	↑↓	• General increase in wet season flows and decrease with overall increase in flow variability • 30–40% decline in the lowest streamflow per decade
Coastal fog	↓	• Weak decline in the frequency of days with coastal fog
Sea level rise	↑	• High likelihood of 0.03–1.24 m (0.1–4.1 ft) sea level rise by 2100
<b>Extreme events and natural disturbance regimes</b>		
Heat waves	↑	• Significant increase in heat wave frequency and duration in coastal areas
Storms & Flooding	↑	• Increased storm intensity and duration, resulting in frequent/intense extreme precipitation events • 300–400% increase in the frequency of 200-year return period events
Drought	↑	• Drought years twice as likely to occur, with signs of prolonged and/or severe drought
Wildfire	↑	• 77% increase in mean annual area burned statewide • 50% increase in the frequency of extremely large fires • Significant increases in fire severity are likely due to behavior combined with human activity and fuel

## Trends and Projections for Climate and Climate-Driven Factors

### Air Temperature

Annual, minimum, and maximum temperatures have increased state-wide over the past century (LaDochy et al. 2007; Cordero et al. 2011; Pierce et al. 2018), with accelerated rates of warming since the 1970s (Cordero et al. 2011). Minimum temperatures (representing nighttime lows) have warmed faster than mean and maximum temperatures in most regions, including northern California (LaDochy et al. 2007; Cordero et al. 2011; Pierce et al. 2018). However, mean annual temperatures have increased less in northern California (+0.6°C [1.0°F]) compared to the state-wide average (+0.8°C [1.5°F]; Grantham 2018; Pierce et al. 2018), and maximum temperatures in the region have exhibited very slight decreases (Rapacciuolo et al. 2014). Within the study area, increases in annual and minimum temperatures over the past century have been greatest in the Great Valley ecoregion; decreases in maximum temperatures are also greatest in this ecoregion (Rapacciuolo et al. 2014).

By the end of the century (2070–2099), annual mean temperatures within the Northern California study area are projected to rise by 2.2–6.1°C (4.0–11.0°F) compared to historical temperatures (1951–1980; Figure 2 and Figure 3), with slightly greater warming projected in summer maximum temperatures (2.0–6.8°C [3.6–12.2°F]) compared to winter minimums (1.9–5.8°C [3.4–10.4°F]; Flint et al. 2013; Flint & Flint 2014; Table 2). Because oceans warm more slowly than land, interior zones are generally projected to experience greater temperature increases than coastal areas ventilated by ocean breezes (Pierce et al. 2018). Other factors associated with landscape-scale temperature variability include elevation and urbanization (LaDochy et al. 2007).

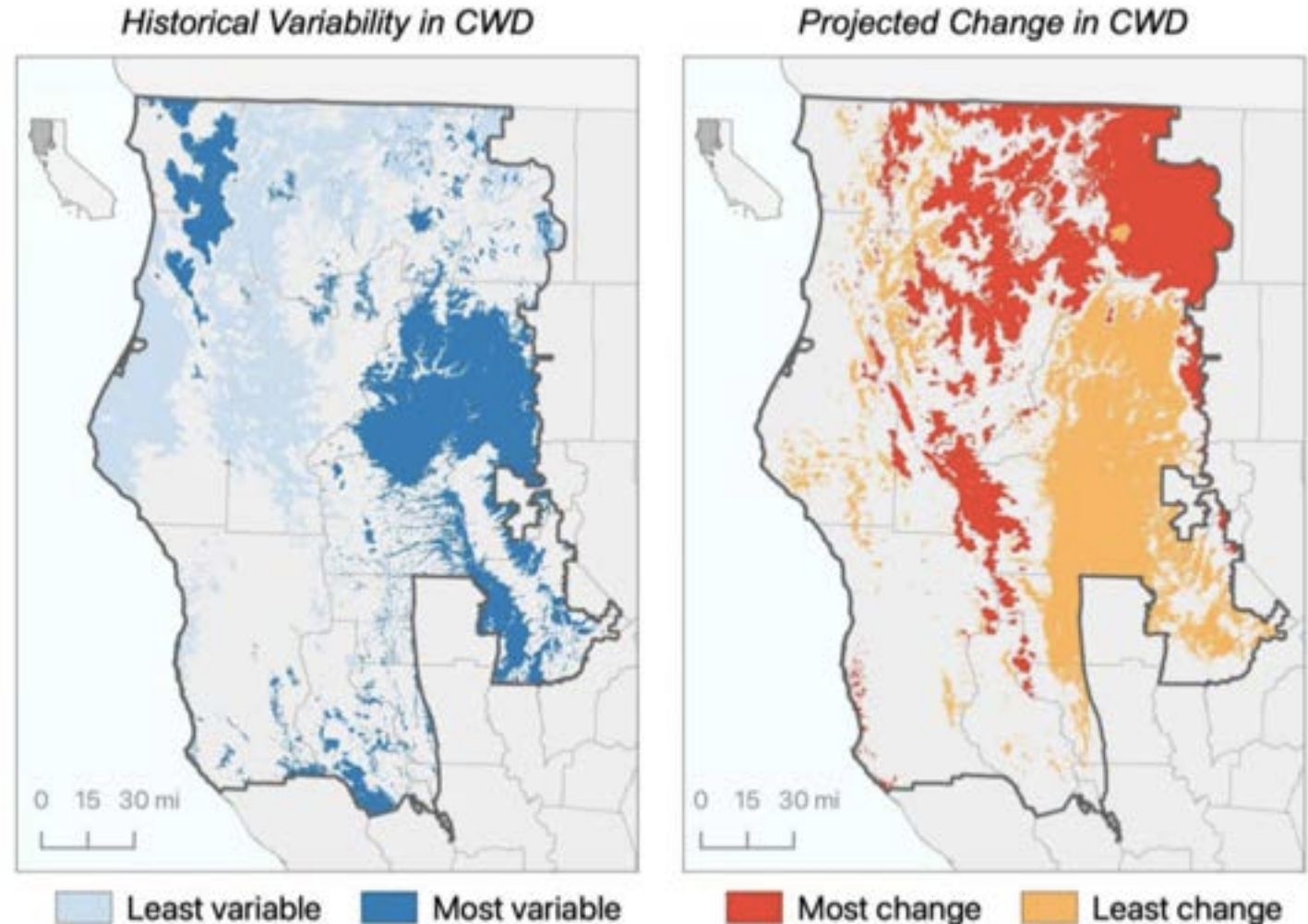


Figure 2. Annual mean temperature in degrees Celsius (°C) for the Northern California Climate Adaptation Project study area between 1951 and 1980.

# Climatic Water Deficit Maps



**Some areas of the  
landscape may be more  
vulnerable to  
significant ecosystem  
changes**

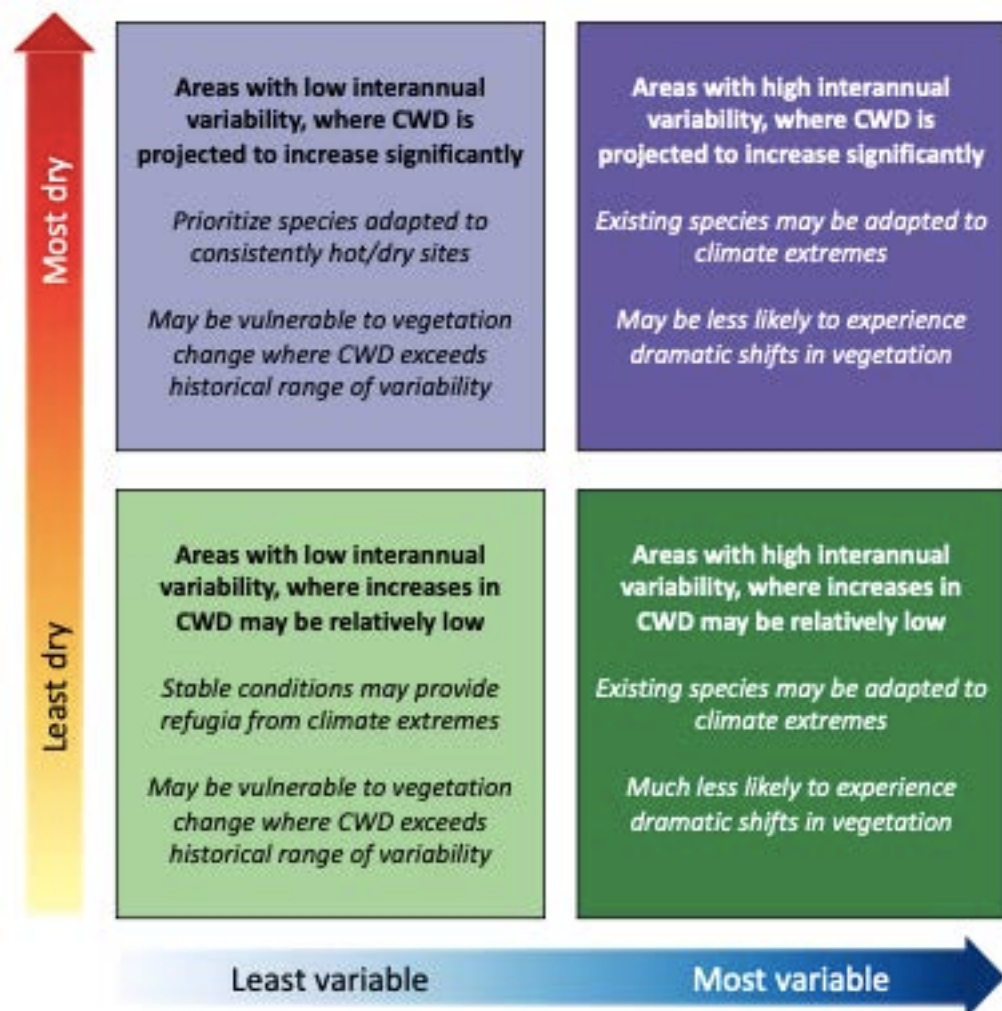


Data Sources: Basin Characterization Model (Flint & Flint 2014);  
Conservation Biology Institute

Map produced by EcoAdapt, Sept. 2021



# Climatic Water Deficit Maps



Least variable/Most change
  Most variable/Most change

Least variable/Least change
  Most variable/Least change

Data Sources: Basin Characterization Model (Flint & Flint 2014); Conservation Biology Institute  
Map produced by EcoAdapt, Sept. 2021

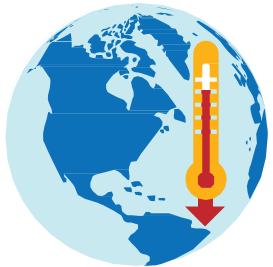




# Climate Change Adaptation

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

## ADAPTATION STRATEGIES:



**Reduce climate impacts**  
*(sensitivity & exposure)*



**Increase climate resilience**  
*(adaptive capacity)*

**Reduce  
climate  
change  
vulnerability**

# Adaptation Approaches



## Resistance/Resilience

Focused on managing for persistence of existing ecosystems

**Example:** Use exclusion fencing in upland areas to prevent herbivory of oak seedlings



## Acceptance

Focused on accommodating change in response to novel conditions

**Example:** Identify areas where post-fire type conversion should be allowed to occur without management intervention



## Direct/Response

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

**Example:** Experiment with seeds from climate analog zones for restoration projects



## Knowledge

Focused on gathering information about climate impacts and/or management effectiveness

**Example:** Expand research on hardwood silviculture techniques, esp. for drought- and heat-tolerant species



## Collaboration

Focused on coordinating management efforts and/or capacity across organizations

**Example:** Develop and/or strengthen new and existing collaborative networks in order to leverage resources

# Adaptation Strategies & Actions



*Product: Suite of adaptation strategies and actions evaluated by criteria meant to assist land managers in identifying and prioritizing actions for implementation*

EcoAdapt\_Northern California Adaptation Strategies & Actions\_Jan2022.xlsx

Home Insert Draw Page Layout Formulas Data Review View

fx -> Species diversity (increases habitat suitability for native flora and fauna)

Adaptation Strategies & Actions for Northern California						VULNERABILITIES ADDRESSED		EFFECTIVENESS AT REDUCING CLIMATE CHANGE VULNERABILITY	
Item	Habitat Group	Management Goal	Adaptation Strategy	Adaptation Action	Adaptation Approach	Climate Impacts Reduced	Adaptive Capacity Factors Enhanced	Overall Effectiveness	Source/Evaluating Effectiveness
3	5 Coastal	Reduce the impact of non-climate stressors	Prevent the introduction and establishment of invasive species and remove existing populations	Remove invasive plants from intact remnant dune habitats to allow for the recovery of native vegetation and natural dune processes	Resistance/Resilience	+ Precipitation, soil moisture, drought (reduces competition for soil moisture) + Sea level rise (allows sand movement necessary for inland habitat migration) + Wildlife (reduces fuel availability/continuity in dunes dominated by invasive species) + Invasive plants	+ Species diversity (increases habitat suitability for native flora and fauna)	High	+ Initial post-restoration data from the Longshore Adaptive Coastal Resilience (LACR) found that removing invasive dune native dune vegetation resulted in a net deposition (erosion) quarterly monitoring intervals over the following year long (https://www.fishwildlife.ca.gov/Policy) + In a comparison of methods of invasive species removal systems, manual removal resulted in species richness, similar to the uninvaded reference site. Herbicide removal persistence of standing biomass, and mechanical removal because they returned the site to bare sand dunes and might facilitate reestablishment of native species. Both he resulted in lower native species richness and species cover reference sites (compared to the manual removal treatment to shorter times since treatment and/or longer recovery is + Full recovery of native dune communities may take particularly long for mechanical removal treatments of
4	2 Coastal	Reduce the impact of non-climate stressors	Prevent the introduction and establishment of invasive species and remove existing populations	Set up an early detection rapid response program to prevent the establishment of invasive species on remnant native-dominated dune systems	Resistance/Resilience	+ Sea temperature (prevents range expansion of invasive plants) + Precipitation, soil moisture, drought (reduces competition for soil moisture) + Sea level rise (allows sand movement necessary for inland habitat migration) + Invasive plants	+ Species diversity (increases habitat suitability for native flora and fauna)	Medium	
5	3 Coastal	Reduce the impact of non-climate stressors	Prevent the introduction and establishment of invasive species and remove existing populations	Increase public awareness of invasive species removal efforts at dune habitats and their role in reducing climate vulnerability	Resistance/Resilience	+ Invasive plants	+ Management potential (increases public understanding that influences coastal support for management)	Low	
6	4 Coastal	Reduce the impact of non-climate stressors	Limit anthropogenic disturbances to sensitive and/or high-quality sites	Protect sensitive dune habitats still dominated by native vegetation from recreational impacts	Resistance/Resilience	+ Recreation (limits disturbance that promotes the spread/establishment of invasive plants) + Invasive plants (prevents displacement of native vegetation and overabundance of mobile dunes)		High	
7	6 Coastal	Sustain fundamental	Restore	Streamline internal and external		+ Wildlife + Fire exclusion (addresses buildup of fuel			

- Effectiveness
- Feasibility
- Co-Benefits & Consequences



# Adaptation Strategies & Actions



EcoAdapt\_Northern California Adaptation Strategies & Actions\_Jan2022.xlsx

Home Insert Draw Page Layout Formulas Data Review View

Search Sheet

Share

Clipboard: Paste, Cut, Copy, Format

Font: Arial 17

Paragraph: Wrap Text, Merge & Center

Conditional Formatting, Format as Table, Cell Styles

Insert, Delete, Format

AutoSum, Fill, Sort & Filter, Find & Select

### Northern California Climate Adaptation Project Adaptation Evaluation Criteria and Definitions

The following table represents a suite of potential adaptation strategies and actions for the Northern California Climate Adaptation Project study area, which were generated by area stakeholders and supplemented by strategies and actions from previous EcoAdapt workshops and sources in the scientific literature (e.g., Karuk Tribe 2019, Vernon et al. 2019, Yurok Tribe 2016, Swenson et al. 2016). Although this table was created for use by the U.S. Forest Service and Bureau of Land Management, the strategies and actions presented here are designed to be applicable across a wide range of other regional conservation efforts such as project planning, and land protection and prioritization efforts.

Each adaptation action listed in this table has been evaluated by a number of criteria meant to assist land managers in identifying and prioritizing actions for implementation. The evaluation criteria used are listed below, along with their definition and rankings (if applicable). Rankings were assigned by EcoAdapt staff based on stakeholder input and experience with previous projects, and backed up by scientific evidence where possible.

Adaptation actions are provided for four habitat groups: coastal habitats, forest and woodland habitats, freshwater habitats, and shrubland and grassland habitats. Actions within each habitat group are nested within broader adaptation strategies, which are themselves grouped into general management goals (organization is based on the adaptation menus from Swenson et al. 2016). Adaptation actions are additionally categorized into five general management approaches: resistance/resilience, acceptance, direct response, knowledge, and collaboration.

Please note that all of the information in columns F-I-S refers back to the adaptation action (Column E).

Column(s)	Definition/Ranking
<b>VULNERABILITIES ADDRESSED</b>	<b>Climate Impacts Reduced</b> Key vulnerabilities that are likely to be reduced by this adaptation action (assuming implementation is successful and occurs at a meaningful/appropriate scale). The vulnerabilities listed here include: • Climate impacts, including climate and climate-driven stressors (e.g., air temperatures, precipitation), climate-driven changes in disturbance regimes (e.g., drought, flooding, wildfires), and non-climate stressors that may interact with climate changes (e.g., invasive species, dams) • Adaptive capacity factors that influence the ability of the target habitat or species to cope with or respond to climate change, including extent and distribution, habitat connectivity, diversity, and management potential, among others
<b>EFFECTIVENESS AT REDUCING CLIMATE CHANGE VULNERABILITY</b>	<b>Adaptive Capacity Factors Enhanced</b> Degree to which implementation of this action reduces resource vulnerability and/or increases resilience to climate change, either directly or indirectly • Assumes action is successfully implemented at a meaningful/appropriate scale (ability to implement the action at a spatial scale that most effectively reduce climate change vulnerability should be reflected in a lower feasibility score) • Actions that indirectly reduce climate change vulnerability may include those that: • Increase the general resilience of the resource (i.e., the ability to absorb and recover from rapid environmental change) • Reduce the impact of non-climate stressors that increase resource sensitivity to climate change by interacting with climate stressors (e.g., invasive species, pollution, water withdrawals, land-use conversion to development, etc.) • Enhance support of or capacity for climate-informed management (e.g., actions focused on research/monitoring, collaborative efforts, policy changes, outreach/education) <b>Overall Effectiveness</b> Key questions: • Will implementing this adaptation action reduce the sensitivity or exposure of this resource to climate stressors or climate-driven changes in disturbance regimes? • Will implementing this adaptation action increase the adaptive capacity of this resource by enhancing its ability to cope with or respond to climate changes? • Will implementing this adaptation action be an effective step in supporting subsequent climate-informed management actions that will reduce climate change vulnerability of the resource? <b>High</b> (very effective) <b>Moderate</b> <b>Low</b> (less effective)
<b>FEASIBILITY OF IMPLEMENTATION AT A SCALE THAT WOULD EFFECTIVELY REDUCE CLIMATE CHANGE</b>	<b>Supporting Evidence for Effectiveness</b> Evidence supporting the effectiveness of the action at directly or indirectly reducing climate change vulnerability, which may include peer-reviewed literature, theses/dissertations, high-quality white papers, traditional ecological knowledge, and/or local knowledge/observations. Note that the addition of evidence sources in this spreadsheet was limited by time constraints; thus, the absence of evidence in this spreadsheet is not meant to imply that evidence does not exist. <b>Overall Feasibility</b> Degree to which action can realistically be implemented at a scale that would effectively reduce climate change vulnerability <b>High</b> (very feasible) <b>Moderate</b> <b>Low</b> (less feasible) <b>Affordability</b> Affordability of fully implementing the action (includes initial cost to implement the action as well as ongoing financial resources needed to sustain the benefits of the action) <b>High</b> (very affordable/inexpensive) <b>Moderate</b> <b>Low</b> (less affordable/expensive) <b>Technical Feasibility</b> Capacity (e.g., time, labor, resources (e.g., equipment) and specialized skills or technology required to implement the action) <b>High</b> (simple/low resources required) <b>Moderate</b> <b>Low</b> (complex/significant resources required)

Adaptation Evaluation Criteria | Adaptation Strategies & Actions | Literature Cited

# Adaptation Strategies & Actions



## Management Goal

- Reduce the impact of non-climate stressors
- Reduce the risk/impacts of severe disturbances and extreme events
- Sustain ecological functions/processes
- Maintain and protect refugia
- Allow/facilitate habitat and species adjustments to better align with changing climate conditions

EcoAdapt\_Northern California Adaptation Strategies & Actions\_Jan2022.xlsx

Search Sheet

Home Insert Draw Page Layout Formulas Data Review View

Adaptation Strategies & Actions for Northern California

Adaptation Strategies & Actions for Northern California						VULNERABILITIES ADDRESSED		EFFECTIVENESS AT REDUCING CLIMATE CHANGE VULNERABILITY	
Item #	Habitat Group	Management Goal	Adaptation Strategy	Adaptation Action	Adaptation Approach	Climate Impacts Reduced	Adaptive Capacity Factors Enhanced	Overall Effectiveness	Sources Evaluating Effectiveness
3	1 Coastal	Reduce the impact of non-climate stressors	Prevent the introduction and establishment of invasive species and remove existing populations	Remove invasive plants from intact remnant dune habitats to allow for the recovery of native vegetation and natural dune processes	Resistance/Resilience	> Precipitation, soil moisture, drought (reduces competition for soil moisture) > Sea level rise (allows sand movement necessary for inland habitat migration) > Wildlife (reduces fuel availability/continuity in dunes dominated by invasive species) > Invasive plants	> Species diversity (increases habitat suitability for native flora and fauna)	High	> Initial post-restoration data from the Langhorne Adaptive Coastal Resilience Site found that removing invasive dune native dune vegetation resulted in net deposition (increased) quarterly monitoring intervals over the following year (July) ( <a href="https://www.friendsofthedunes.org/wordpress/">https://www.friendsofthedunes.org/wordpress/</a> ) > In a comparison of methods of invasive species removal: systems, manual removal resulted in species richness, cover similar to the uninvaded reference site. Herbicide treatment persistence of standing biomass, and mechanical treatment because they returned the site to bare sand destroyed sarg might facilitate reestablishment of native species. Both he resulted in lower native species richness and species cover reference sites (compared to the manual removal treatment to shorter times since treatment and/or longer recovery time) > Full recovery of native dune communities may take at least particularly long for mechanical removal treatments (Pickett)
4	2 Coastal	Reduce the impact of non-climate stressors	Prevent the introduction and establishment of invasive species and remove existing populations	Set up an early detection-rapid response program to prevent the establishment of invasive species on remnant native-dominated dune systems	Resistance/Resilience	> Air temperature (prevents range expansion of invasive plants) > Precipitation, soil moisture, drought (reduces competition for soil moisture) > Sea level rise (allows sand movement necessary for inland habitat migration) > Invasive plants	> Species diversity (increases habitat suitability for native flora and fauna)	Moderate	
5	3 Coastal	Reduce the impact of non-climate stressors	Prevent the introduction and establishment of invasive species and remove existing populations	Increase public awareness of invasive species removal efforts in dune habitats and their role in reducing climate vulnerability	Resistance/Resilience Collaboration	> Invasive plants	> Management potential (increases public understanding that influences societal support for management)	Low	
6	4 Coastal	Reduce the impact of non-climate stressors	Limit anthropogenic disturbances on sensitive and/or high-quality sites	Protect sensitive dune habitats still dominated by native vegetation from recreational impacts	Resistance/Resilience	> Recreation (limits disturbance that promotes the spread/establishment of invasive plants) > Invasive plants (prevents displacement of native vegetation and overcolonization of mobile dunes) > Wildlife > Fire exclusion (addresses buildup of fuels that contribute to climate-driven changes in fire patterns)	> Management potential (increases understanding that influences societal support for management)	High	
7	5 Coastal	Sustain fundamental ecological functions and processes	Revise the role of fire as an ecological process on the dune system	Streamline internal and external permitting process for the use of fire	Resistance/Resilience	> Fire exclusion (addresses buildup of fuels that contribute to climate-driven changes in fire patterns)	> Management potential (increases understanding that influences societal support for management)	High	

Adaptation Evaluation Criteria Adaptation Strategies & Actions Literature Cited

# Adaptation Strategies & Actions



EcoAdapt\_Northern California Adaptation Strategies & Actions\_Jan2022.xlsx

Search Sheet

Home Insert Draw Page Layout Formulas Data Review View

Adaptation Strategies & Actions for Northern California

Adaptation Strategies & Actions for Northern California						VULNERABILITIES ADDRESSED		EFFECTIVENESS AT REDUCING CLIMATE CHANGE VULNERABILITY	
Sort B = 1	Habitat Group	Management Goal	Adaptation Strategy	Adaptation Action	Adaptation Approach	Climate Impacts Reduced	Adaptive Capacity Factors Enhanced	Overall Effectiveness	Sources Evaluating Effectiveness
3	1 Coastal	Reduce the impact of non-climate stressors	Prevent the introduction and establishment of invasive species and remove existing populations	Remove invasive plants from intact remnant dune habitats to allow for the recovery of native vegetation and natural dune processes	Resistance/Resilience	<ul style="list-style-type: none"> <li>&gt; Precipitation, soil moisture, drought (reduces competition for soil moisture)</li> <li>&gt; Sea level rise (allows sand movement necessary for inland habitat migration)</li> <li>&gt; Wildlife (reduces fuel availability/continuity in dunes dominated by invasive species)</li> <li>&gt; Invasive plants</li> </ul>	> Species diversity (increases habitat suitability for native flora and fauna)	High	<ul style="list-style-type: none"> <li>&gt; Initial post-restoration data from the Langhorne Adaptive Coastal Resilience Site found that removing invasive dune native dune vegetation resulted in net deposition (increased quarterly monitoring intervals over the following year (July (https://www.friendsofthedunes.org/))</li> <li>&gt; In a comparison of methods of invasive species removal: systems, manual removal resulted in species richness, cover similar to the uninvaded reference site. Herbicide treatment persistence of standing biomass, and mechanical treatment because they returned the site to bare sand destroyed sarg might facilitate reestablishment of native species. Both he resulted in lower native species richness and species cover reference sites (compared to the manual removal treatment to shorter times since treatment and/or longer recovery if)</li> <li>&gt; Full recovery of native dune communities may take at least particularly long for mechanical removal treatments (Pick)</li> </ul>
4	2 Coastal	Reduce the impact of non-climate stressors	Prevent the introduction and establishment of invasive species and remove existing populations	Set up an early detection rapid response program to prevent the establishment of invasive species on remnant native-dominated dune systems	Resistance/Resilience	<ul style="list-style-type: none"> <li>&gt; Air temperature (prevents range expansion of invasive plants)</li> <li>&gt; Precipitation, soil moisture, drought (reduces competition for soil moisture)</li> <li>&gt; Sea level rise (allows sand movement necessary for inland habitat migration)</li> <li>&gt; Invasive plants</li> </ul>	> Species diversity (increases habitat suitability for native flora and fauna)	Moderate	
5	3 Coastal	Reduce the impact of non-climate stressors	Prevent the introduction and establishment of invasive species and remove existing populations	Increase public awareness of invasive species removal efforts in dune habitats and their role in reducing climate vulnerability	Resistance/Resilience Collaboration	> Invasive plants	> Management potential (increases public understanding that influences societal support for management)	Low	
6	4 Coastal	Reduce the impact of non-climate stressors	Limit anthropogenic disturbances on sensitive and/or high-quality sites	Protect sensitive dune habitats still dominated by native vegetation from recreational impacts	Resistance/Resilience	<ul style="list-style-type: none"> <li>&gt; Recreation (limits disturbance that promotes the spread/establishment of invasive plants)</li> <li>&gt; Invasive plants (prevents displacement of native vegetation and overcolonization of mobile dunes)</li> </ul>		High	
7		Sustain fundamental ecological functions and	Restore the role of fire as an ecological process on the	Streamline internal and external permitting process for the use of		<ul style="list-style-type: none"> <li>&gt; Wildlife</li> <li>&gt; Fire exclusion (addresses buildup of fuels that contribute to climate-driven changes)</li> </ul>	> Management potential (increases		

Adaptation Evaluation Criteria | Adaptation Strategies & Actions | Literature Cited

Ready

Management Goal

Strategy

- Prevent the introduction & establishment of invasive species
- Restore the role of fire as an ecological process on the landscape
- Maintain/create migration corridors for native plants/wildlife





# Adaptation Strategies & Actions



EcoAdapt\_Northern California Adaptation Strategies & Actions\_Jan2022.xlsx

Search Sheet

Home Insert Draw Page Layout Formulas Data Review View

Adaptation Strategies & Actions for Northern California

Adaptation Strategies & Actions for Northern California						VULNERABILITIES ADDRESSED		EFFECTIVENESS AT REDUCING CLIMATE CHANGE VULNERABILITY	
Sort B = 1	Habitat Group	Management Goal	Adaptation Strategy	Adaptation Action	Adaptation Approach	Climate Impacts Reduced	Adaptive Capacity Factors Enhanced	Overall Effectiveness	Sources Evaluating Effectiveness
3	1 Coastal	Reduce the impact of non-climate stressors	Prevent the introduction and establishment of invasive species and remove existing populations	Remove invasive plants from intact remnant dune habitats to allow for the recovery of native vegetation and natural dune processes	Resistance/Resilience	Precipitation, soil moisture, drought (reduces competition for soil moisture) Sea level rise (allows sand movement necessary for inland habitat migration) Wildfire (reduces fuel availability/continuity in dunes dominated by invasive species) Invasive plants	Species diversity (increases habitat suitability for native flora and fauna)	High	> Initial post-restoration data from the Langhorne Adaptive Coastal Resilience Site found that removing invasive dune native dune vegetation resulted in net deposition (increased quarterly monitoring intervals over the following year (July (https://www.fishandwildlife.ca.gov/Species/Invasive/Invasive-Plant-Removal-Data)) > In a comparison of methods of invasive species removal: systems, manual removal resulted in species richness, cover similar to the uninvaded reference site. Herbicide treatment persistence of standing biomass, and mechanical treatment because they returned the site to bare sand destroyed sarg might facilitate reestablishment of native species. Both he resulted in lower native species richness and species cover reference sites (compared to the manual removal treatment to shorter times since treatment and/or longer recovery if it all recovery of native dune communities may take at is particularly long for mechanical removal treatments (Picks
4	2 Coastal	Reduce the impact of non-climate stressors	Prevent the introduction and establishment of invasive species and remove existing populations	Set up an early detection rapid response program to prevent the establishment of invasive species on remnant native-dominated dune systems	Resistance/Resilience	Air temperature (prevents range expansion of invasive plants) Precipitation, soil moisture, drought (reduces competition for soil moisture) Sea level rise (allows sand movement necessary for inland habitat migration) Invasive plants	Species diversity (increases habitat suitability for native flora and fauna)	Moderate	
5	3 Coastal	Reduce the impact of non-climate stressors	Prevent the introduction and establishment of invasive species and remove existing populations	Increase public awareness of invasive species removal efforts in dune habitats and their role in reducing climate vulnerability	Resistance/Resilience Collaboration	Invasive plants	Management potential (increases public understanding that influences societal support for management)	Low	
6	4 Coastal	Reduce the impact of non-climate stressors	Limit anthropogenic disturbances on sensitive and/or high-quality sites	Protect sensitive dune habitats still dominated by native vegetation from recreational impacts	Resistance/Resilience	Recreation (limits disturbance that promotes the spread/establishment of invasive plants) Invasive plants (prevents displacement of native vegetation and overcolonization of mobile dunes)		High	
7		Sustain fundamental ecological functions and	Revise the role of fire as an ecological process on the	Streamline internal and external permitting process for the use of		Wildfire Fire exclusion (addresses buildup of fuels that contribute to climate-driven changes in fire patterns)	Management potential (increases		

Ready

Management Goal

Strategy

Action

- Remove invasive plants from intact remnant dune habitats to allow for the recovery of native vegetation and natural dune processes

# Adaptation Strategies & Actions



E		I		J		K		L	
California		EFFECTIVENESS AT REDUCING CLIMATE CHANGE VULNERABILITY				FEASIBILITY OF IMPLEMENTATION			
Adaptation Action	Overall Effectiveness	Sources Evaluating Effectiveness				Overall Feasibility	Affordability		
Remove invasive plants from intact remnant dune habitats to allow for the recovery of native vegetation and natural dune processes	High	<p>&gt; Initial post-restoration data from the Lanphere Adaptation Site (part of the Humboldt Coastal Resilience Site) found that removing invasive dune grasses followed by planting native dune vegetation resulted in net deposition (increased foredune volume) during all quarterly monitoring intervals over the following year (unpublished, but see progress report (<a href="https://www.friendsofthedunes.org/hcrp">https://www.friendsofthedunes.org/hcrp</a>))</p> <p>&gt; In a comparison of methods of invasive species removal in 3 northern California dune systems, manual removal resulted in species richness, cover, and composition that was most similar to the uninvaded reference site. Herbicide treatments resulted in higher cover to the persistence of standing biomass, and mechanical treatments resulted in lower cover, likely because they returned the site to bare sand destroyed organic matter and soil biota that might facilitate reestablishment of native species. Both herbicide and mechanical treatments resulted in lower native species richness and species composition that was less similar to the reference sites (compared to the manual removal treatments), though this may be partly due to shorter times since treatment and/or longer recovery times necessary (Pickart et al. 2021)</p> <p>&gt; Full recovery of native dune communities may take at least to 20 years, and is likely to be particularly long for mechanical removal treatments (Pickart et al. 2021)</p>				Moderate	<p>Moderate</p> <p>&gt; Eradication requires ongoing investment over multiple years</p> <p>&gt; Cost varies by method of removal: manual removal is very expensive, mechanical removal is less so, and herbicide or a combination of burning, herbicide is relatively inexpensive (Fickert et al. 2021)</p>		

## Will implementing this adaptation action reduce climate change vulnerability?

- Directly reducing impacts of climate stressors or climate-driven changes in disturbance regimes
- Reducing impacts of non-climate stressors that interact with climate changes
- Increasing general resilience of the resource (e.g., ability to absorb/recover from rapid change)
- Enhancing support/capacity for climate-informed management



# Adaptation Strategies & Actions



E	K	L	M	N	O
alifornia	FEASIBILITY OF IMPLEMENTATION AT A SCALE THAT WOULD EFFECTIVELY REDUCE CLIMATE CHANGE VULNERABILITY				
Adaptation Action	Overall Feasibility	Affordability	Technical Feasibility	Institutional/Legal Feasibility	Sociopolitical Support
Remove invasive plants from intact remnant dune habitats to allow for the recovery of native vegetation and natural dune processes	Moderate	Moderate  > Eradication requires ongoing investment over multiple years > Cost varies by method of removal - manual removal is very expensive, mechanical removal is less so, and herbicide or a combination of burning and herbicide is relatively inexpensive (Pickart et al. 2021)	Moderate  > Treatments often must be repeated for full eradication to occur > Manual removal is very labor-intensive and difficult because of the deep rhizome systems of invasive dune grasses; there are also logistical challenges related to the need to repeatedly access remote sites for retreatment (Pickart et al. 2021) > Mechanical removal with bulldozers and excavators is less labor-intensive and less logistically challenging, making it more feasible to treat larger areas (Pickart et al. 2021)	Moderate  > Many of the remaining degraded dune areas are owned privately or by local agencies, who generally do not implement large-scale restoration projects	Moderate  > Possible conflict if the public (including adjacent landowners) believes that dune stabilization by invasive species is necessary to prevent erosion and reduce flooding risk

## How feasible is it to implement this action at a scale that would reduce vulnerability?

- **Affordability** – Initial and ongoing costs associated with implementing the action & maintaining benefits of the action
- **Technical Feasibility** – Time/labor, equipment, specialized technology/skills, other resources needed to implement the action

# Adaptation Strategies & Actions



E	K	L	M	N	O
alifornia	FEASIBILITY OF IMPLEMENTATION AT A SCALE THAT WOULD EFFECTIVELY REDUCE CLIMATE CHANGE VULNERABILITY				
Adaptation Action	Overall Feasibility	Affordability	Technical Feasibility	Institutional/Legal Feasibility	Sociopolitical Support
Remove invasive plants from intact remnant dune habitats to allow for the recovery of native vegetation and natural dune processes	Moderate	<p>Moderate</p> <p>&gt; Eradication requires ongoing investment over multiple years</p> <p>&gt; Cost varies by method of removal - manual removal is very expensive, mechanical removal is less so, and herbicide or a combination of burning and herbicide is relatively inexpensive (Pickart et al. 2021)</p>	<p>Moderate</p> <p>&gt; Treatments often must be repeated for full eradication to occur</p> <p>&gt; Manual removal is very labor-intensive and difficult because of the deep rhizome systems of invasive dune grasses; there are also logistical challenges related to the need to repeatedly access remote sites for retreatment (Pickart et al. 2021)</p> <p>&gt; Mechanical removal with bulldozers and excavators is less labor-intensive and less logistically challenging, making it more feasible to treat larger areas (Pickart et al. 2021)</p>	<p>Moderate</p> <p>&gt; Many of the remaining degraded dune areas are owned privately or by local agencies, who generally do not implement large-scale restoration projects</p>	<p>Moderate</p> <p>&gt; Possible conflict if the public (including adjacent landowners) believes that dune stabilization by invasive species is necessary to prevent erosion and reduce flooding risk</p>

## How feasible is it to implement this action at a scale that would reduce vulnerability?

- **Institutional/Legal Feasibility** – Regulatory/administrative requirements, policy conflicts, potential legal challenges that may impact ability to implement the action
- **Sociopolitical Support** – Public and/or political backing for implementation of the action



# Adaptation Strategies & Actions

E	P	O	R	
alifornia	CO-BENEFITS & CONSEQUENCES			
Adaptation Action	Impacts on Non-Target Habitats and Species	Impacts on Human Well-being	Impacts on Climate Mitigation Efforts	Where/When/How
Remove invasive plants from intact remnant dune habitats to allow for the recovery of native vegetation and natural dune processes	<p>(+) Threatened/endangered plant and wildlife species, including migratory shorebirds</p> <p>(+) Pollinators (attracted by increased diversity of native flora)</p> <p>(-) Amphibians (frequently occupy coastal dune drainages in northern California where invasive plants have overstabilized the dunes; Halstead &amp; Kleeman 2017)</p>	<p>(+) Flood protection (if dunes are able to persist by migrating inland)</p> <p>(+) Recreation</p> <p>(+) Aesthetic values/beauty (increased native flora includes colorful wildflowers that attract pollinators such as butterflies)</p> <p>(-) Recreation (recovery of threatened/endangered species might result in reduced availability of land for public use, at least in some areas and/or seasons)</p>	<p>(-) Reduces overall vegetative cover on dunes that were stabilized and become more mobile</p>	<p>&gt; Prioritize higher-elevation areas away from erosion increases</p> <p>&gt; Depending on site-specific characteristics of invasive species</p> <p>&gt; Periodic re-treatment will likely be required</p>

**Are there co-benefits or potential conflicts/unintended consequences of the action?**

- **Impacts on non-target habitats, species, and/or ecosystem services**
- **Impacts on human well-being** – Food security, water supplies/quality, air quality, flood control, health/safety, recreation, economic opportunities (e.g., jobs), cultural well-being (e.g., availability of valued species, ability to maintain traditional practices, tribal sovereignty), sense of place, beauty





# Adaptation Strategies & Actions

E	P	O	R	
alifornia	CO-BENEFITS & CONSEQUENCES			
Adaptation Action	Impacts on Non-Target Habitats and Species	Impacts on Human Well-being	Impacts on Climate Mitigation Efforts	Where/When/How
Remove invasive plants from intact remnant dune habitats to allow for the recovery of native vegetation and natural dune processes	<p>(+) Threatened/endangered plant and wildlife species, including migratory shorebirds</p> <p>(+) Pollinators (attracted by increased diversity of native flora)</p> <p>(-) Amphibians (frequently occupy coastal dune drainages in northern California where invasive plants have overstabilized the dunes; Halstead &amp; Kleeman 2017)</p>	<p>(+) Flood protection (if dunes are able to persist by migrating inland)</p> <p>(+) Recreation</p> <p>(+) Aesthetic values/beauty (increased native flora includes colorful wildflowers that attract pollinators such as butterflies)</p> <p>(-) Recreation (recovery of threatened/endangered species might result in reduced availability of land for public use, at least in some areas and/or seasons)</p>	<p>(-) Reduces overall vegetative cover on dunes that were stabilized and become more mobile</p>	<p>&gt; Prioritize higher-elevation areas away from erosion increases</p> <p>&gt; Depending on site-specific characteristics of invasive species</p> <p>&gt; Periodic re-treatment will likely be required</p>

**Are there co-benefits or potential conflicts/unintended consequences of the action?**

- **Impacts on climate mitigation efforts** – Greenhouse gas emissions, rate of carbon sequestration, carbon stocks

# Adaptation Strategies & Actions



E	S	T	U	V	W	X
California	IMPLEMENTATION DETAILS					
Adaptation Action	Where/When/How					
Remove invasive plants from intact remnant dune habitats to allow for the recovery of native vegetation and natural dune processes	<ul style="list-style-type: none"><li>&gt; Prioritize higher-elevation areas away from bluff edges and other locations more likely to persist as sea levels rise and erosion increases</li><li>&gt; Depending on site-specific characteristics, use hand-pulling, mechanical removal, or prescribed pile burning to remove invasive species</li><li>&gt; Periodic re-treatment will likely be required in an ongoing way</li></ul>					

Where, when, and how should this action be implemented?



# Vulnerability-Adaptation Summaries

*Product: Vulnerability-adaptation summaries linking suite of adaptation strategies & actions to identified vulnerabilities*

- Summary of key habitat and species vulnerabilities
- Table linking suite of adaptation strategies & actions to identified vulnerabilities





# Vulnerability-Adaptation Summaries



## Key Climate Vulnerabilities

### Forest and Woodland Habitats

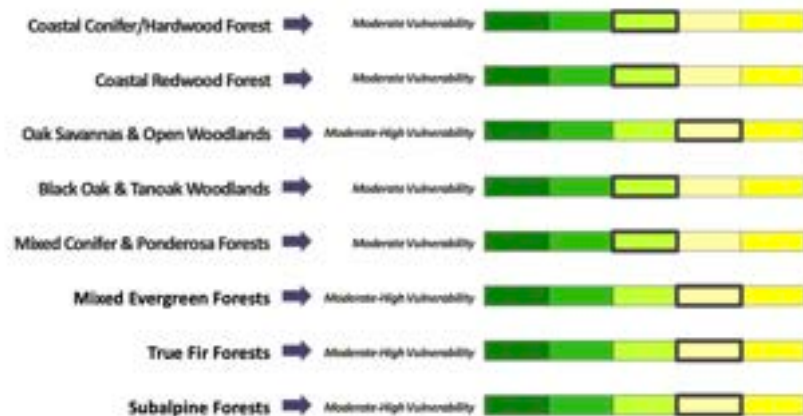
Forest and woodland habitats in northwestern California are primarily sensitive to climate stressors that increase moisture stress, resulting in shifts in tree growth and recruitment as well as species composition and habitat structure. Changes in the frequency and/or intensity of disturbances (e.g., wildfire, insects, disease) may also cause more extensive tree mortality, especially where increased competition for soil moisture reduces tree vigor. Historical logging followed by decades of fire exclusion has significantly altered most forests and woodlands in the region, simplifying habitat structure and increasing vulnerability to disturbance-related mortality.

Forests and woodlands are extensive across northwestern California, although the extent and integrity of some types have declined significantly. High physical/topographic diversity in the region increases resistance to climate stressors and disturbances, but moisture-stressed forests exhibit delayed recovery from disturbances. Generally, high public and societal value increases support for management, and many management actions are known to effectively reduce the impacts of climate change.



Photo by Bob WALKER (CC BY 2.0)

### Vulnerability Rankings for Forest and Woodland Habitats



## Sensitivity & Exposure

Potential impacts of projected climate changes on forest and woodland habitats in northwestern California include:

- Altered patterns of tree survival and recruitment due to moisture stress, resulting in shifts in species composition and increased vulnerability
- Possible increases in high elevations due to increased tree mortality
- Increased tree mortality due to increased competition for soil moisture
- Possible type conversion of some forest types to woodlands
- Shifts in habitat structure and composition
- Loss of culturally-valued and fungal resources

### Non-climate stressors

- Fire exclusion/suppression well as the availability of resources due to non-climate recreation)
- Greater vulnerability for coastal/marine (e.g., marbled murrelet)

### Adaptive Capacity

Intrinsic (i.e., inherent or undermine the ability to adapt)

### Intrinsic factors:

- ▲ Extensive distribution
- ▲ Heterogeneous landscape
- ▲ Species diversity, including from disturbances
- ▲ Many species/habitats

### Extrinsic factors:

- ▲ Significant cultural value
- ▲ Provide critical ecosystem services
- ▲ Climate-informed management knowledge and skills

## Key Climate Vulnerabilities Forest- and Woodland

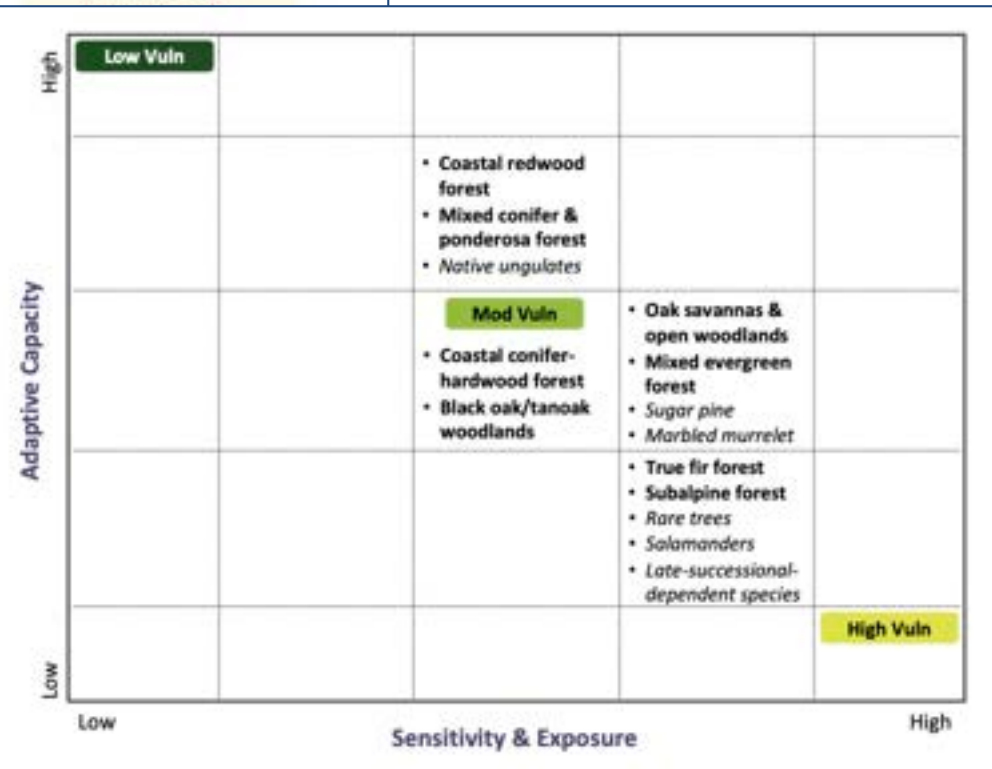
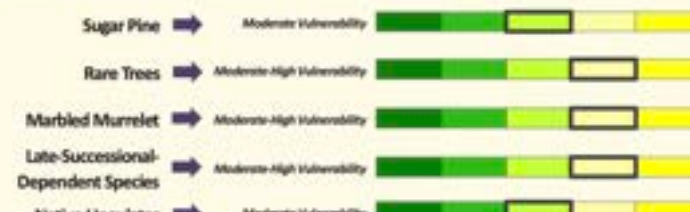
Changes in climate factors and connectivity are likely to impact include sugar pine, rare trees, and dependent species, native ungulates

- Changes in animal physiology, temperatures and more extreme weather events
- Changes in availability of species to altered plant composition
- Reduced forage/prey and water availability
- Changes in species distribution, competition for habitat and food
- Increased mortality, habitat loss, and reduced resources due to non-climate recreation)
- Greater vulnerability for coastal/marine (e.g., marbled murrelet)

### Factors that enhance or undermine adaptive capacity

- ▲ Greater ability to respond to stressors in highly mobile species
- ▲ High genetic/phenotypic diversity
- ▲ High public/cultural value of species
- ▲ Increasing support for management
- ▲ Regulatory/legislative support for management of federal- or state-listed species

### Vulnerability Rankings for Forest and Woodland Habitats



Recovery in many species limited by low reproductive potential and/or reliance on specialized habitat conditions



# Vulnerability-Adaptation Summaries

## GOAL 1. REDUCE THE IMPACT OF NON-CLIMATE STRESSORS

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

## GOAL 8. MAINTAIN AND PROTECT REFUGIA

1.3 **8.1 Prioritize and maintain sites that may be more resistant to changes in climate (e.g., cooler, wetter sites), harbor high biodiversity, and/or provide habitat for rare species**

## GOAL

*Example adaptation actions:*

2.1 U • Identify forest areas of least/slower change to support the protection and management of potential climate change  
2.2 Er refugia **(R/K)**

**GOAL** • Protect mature and late-successional forests **(R)**

3.1 R • Expand reserve boundaries to include mid-seral and complex early-seral forests that have high structural diversity  
3.2 R and the potential to develop old-growth characteristics over time **(R)**

3.3 R *Vulnerabilities addressed:*

**GOAL**  
4.1 In ✓ Land-use conversion and human land uses that result in habitat loss and fragmentation  
✓ Air temperature, precipitation, soil moisture, drought, wildfire (*loss of cool, moist refugia in mature and late-successional forests*)  
✓ Habitat diversity (*loss of structural complexity and range of successional stages*)

# Adaptation Implementation Workshop Proceedings



## *Product: Proceedings from November 2021 Adaptation Implementation Workshops*

- Overview of climate adaptation planning
- Description of workshop activities
- Review of priority sites selected for implementation planning
- Adaptation implementation plans created by workshop participants for 6 priority sites in the northwestern California study area

### *Northern California Climate Adaptation Project Adaptation Implementation Workshop Proceedings*

2021





# Priority Site Selection



Site Name	Value	Condition	Suitability	Adaptation Approach
Rancho Breisgau riparian oak woodland	High	Poor	Suitable	Resistance/Resilience
Plaskett-Keller Post-Fire Restoration Site, Mendocino National Forest	High	Poor	Suitable	Resistance/Resilience
East Fork Scott River meadow/floodplain complex	High	Moderate to Poor	Probably unsuitable	Resistance/Resilience Direct/Respond Acceptance
North Spit Humboldt Bay	High	Moderate	Suitable	Resistance/Resilience
Black oak and tanoak stands on Yurok tribal lands	High	Poor	Suitable	Resistance/Resilience
Indian Creek watershed of the Mid-Klamath	High	Poor	Uncertain	Resistance/Resilience Direct/Respond Acceptance

# Adaptation Implementation Plans



## Adaptation Implementation Plan for Plaskett-Keller Post-Fire Restoration Site, Mendocino National Forest

### SECTION 1. BACKGROUND

**PROJECT SITE:** Plaskett-Keller Post-Fire Restoration Site, Mendocino National Forest

<b>Value:</b> High	<b>Current Condition:</b> Poor	<b>Future Suitability:</b> Suitable	<b>Potential Approach:</b> Resistance/Resilience
--------------------	--------------------------------	-------------------------------------	--

**Overarching management goal:** Manage fuels to reduce future wildfire risk in shrublands (and preserve connectivity of shrublands with forest), post-fire restoration, increase shrubland and hydrologic connectivity

**Key climate-related vulnerabilities to be addressed:**

- Extreme hydrologic events (e.g., atmospheric rivers)
- More rain, less snow
- Increased temperatures & climatic water deficit → more severe wildfire in the future
  - Altered watershed response – loss of soil productivity (loss of permeability), water moves offsite quicker
- Decreased ability of landscape to support conifers (primarily driven by increased water stress)

**Potential barriers to meeting management goal:**

- Mixed ownership
- Grazing represents a challenge for grassland health (invasive spp.) & fire recovery in general
- Lack of resources (personnel, \$\$)
- Potential concern from local tribes about management of the land (unknown at this time)
- Conifer dominance in FS (cultural challenge)
  - Grasslands/Shrublands don't have the monetary/cultural backing that the conifers do

**Potential conflicts or unintended consequences with non-target ecosystems/species, human communities, and/or other management goals:**

- Potential impacts to the wild and scenic river corridor
- Summer homes and camp ground in the project area – public use is a concern
- FS likes to manage forest – grassland/shrubland are not a priority (not actively managed at this point)



*The Black Butte River Valley in Mendocino National Forest, which was burned in the 2020 August Complex Fire. (Photo © Chad Roberts)*



## Northern California Climate Adaptation Products

The goal of the Northern California Climate Adaptation Project is to increase the understanding of and capacity to reduce climate-related vulnerabilities of habitats and species of natural and cultural importance in northwestern California. For more information about the project, please visit the [project page](#).

### Product Descriptions

The [Overview of Climate Trends and Projections](#) summarizes observed changes and expected future conditions for the Northern California Climate Adaptation Project study area.

The [Vulnerability/Adaptation Summaries](#) (linked below) provide a high-level overview of vulnerability for habitats and associated species within the four major habitat groups (coastal habitats, forest and woodland habitats, freshwater habitats, and shrubland and grassland habitats), as well as a table of adaptation strategies and actions linked to those vulnerabilities.

The [Vulnerability Assessment Syntheses](#) (linked below) provide an in-depth review of how habitats and species are likely to be impacted by climate change, and include information gathered from regional experts, the scientific literature, and peer-review comments and revisions. Each synthesis examines the sensitivity of a given habitat, species, or species group to climate change, its exposure to projected changes, and its capacity to adapt. The aim of these syntheses is to expand understanding of habitat and species vulnerability to changing climate conditions, and to provide a foundation for developing appropriate adaptation responses.

The [Adaptation Strategies and Actions Table](#) presents a suite of potential adaptation strategies and actions for the northern California study area, which were generated by area stakeholders and supplemented by strategies and actions from previous EcoAdapt workshops and sources in the scientific literature. Adaptation actions are provided for the four major habitat groups, and action listed in the table has been evaluated by a number of criteria meant to assist land managers in identifying and prioritizing actions for implementation (e.g., effectiveness, feasibility, potential co-benefits, and consequences).

The [Adaptation Implementation Workshop Proceedings](#) summarize the activities and outcomes of the Northern California Adaptation Implementation Workshops held for the Redding and Eureka/Arcata regions in November 2021. The report includes an overview of climate adaptation planning and a description of the workshop activities, then presents adaptation implementation plans created by workshop participants for six priority sites within the northwestern California study area.

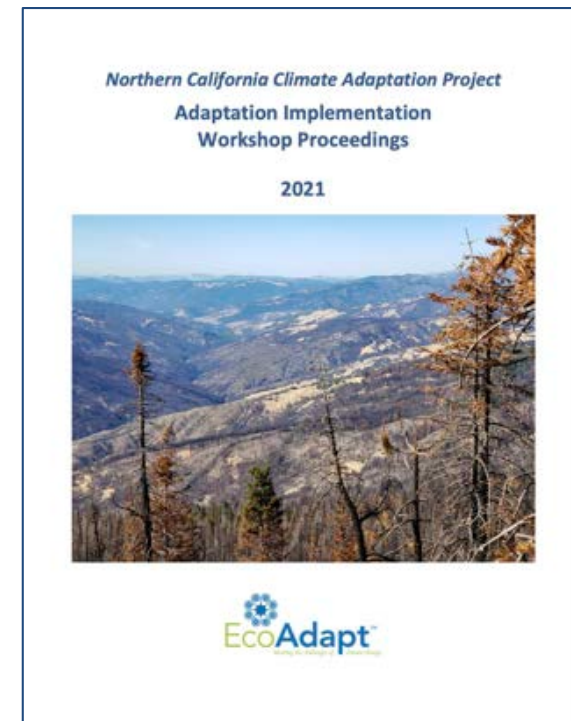
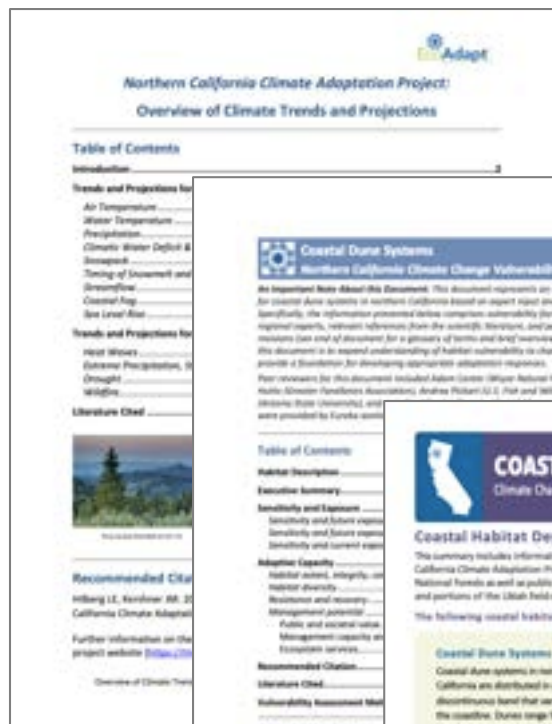
### Coastal Habitats

#### Vulnerability/Adaptation Summary

#### Vulnerability Assessment Syntheses

Habitats: [Coastal Dune Systems](#)  
[Coastal Bluffs & Scrub](#)

# Products







# Questions?

Laura Hilberg, Lead Scientist

[laura.hilberg@ecoadapt.org](mailto:laura.hilberg@ecoadapt.org)

<https://tinyurl.com/NorCalAdaptation>

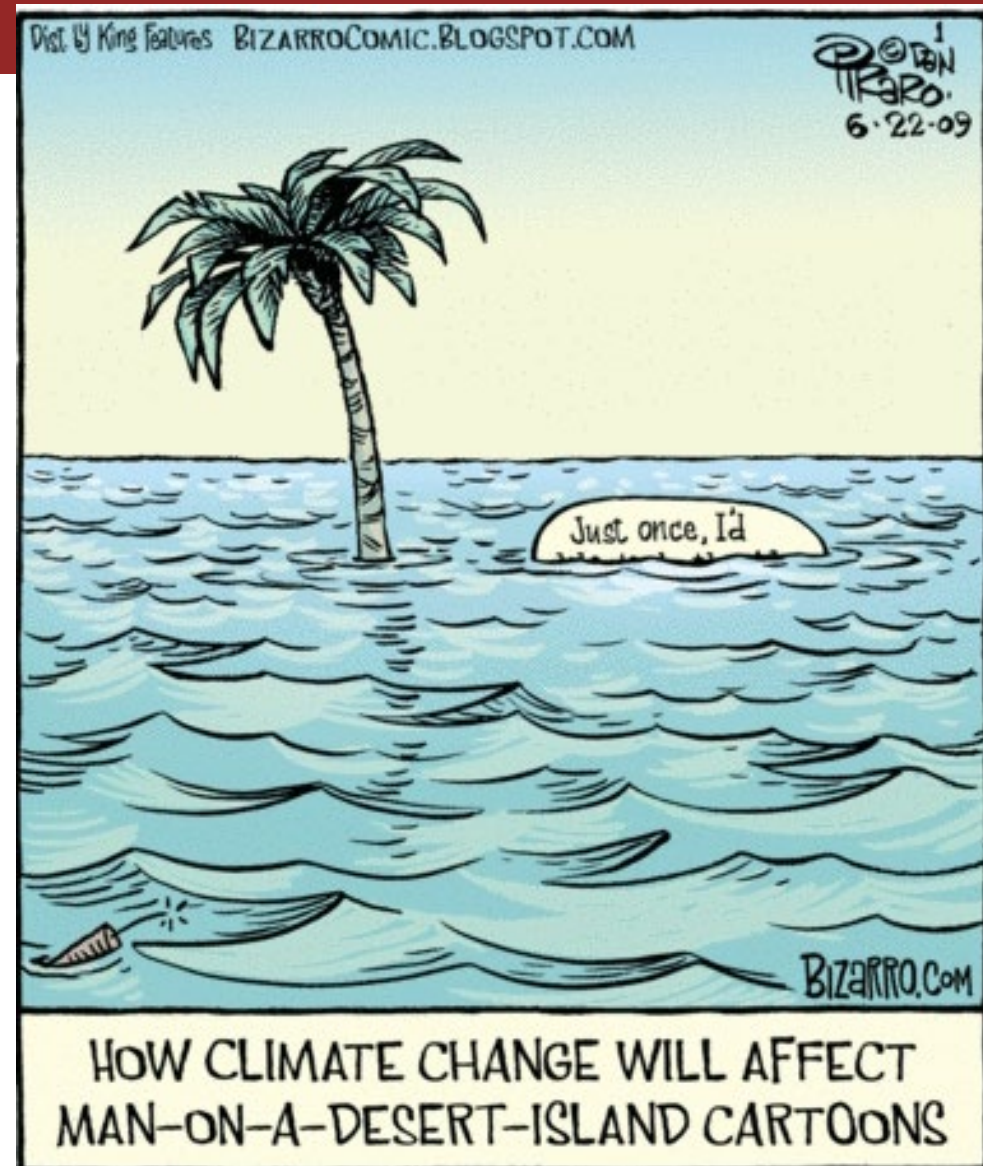




Photo by USFWS via Flickr (Public Domain)

# Thank You!

*Webinar recording will be sent to all  
registrants and posted online with the slides at  
<https://tinyurl.com/NorCalAdaptation>*

