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# Santa Cruz Mountains Climate Adaptation Project

## Vulnerability Assessment Results



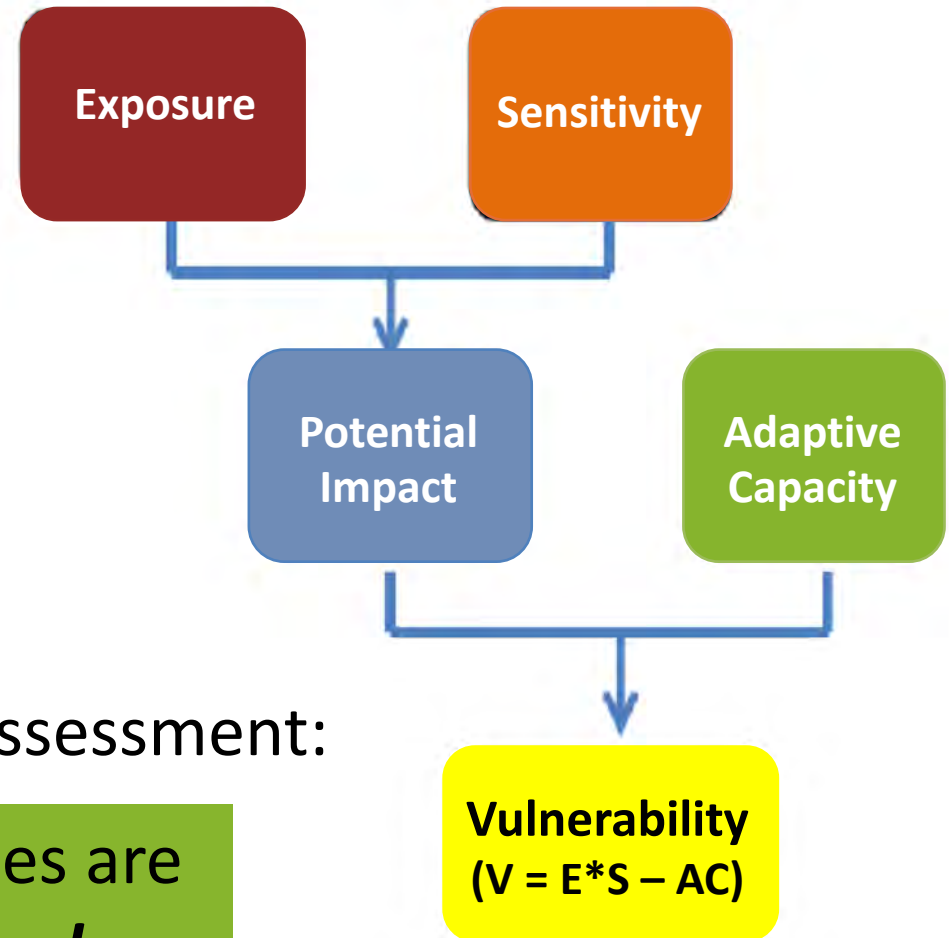
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# Vulnerability Assessment

Vulnerability is....a function of the ***sensitivity*** of a particular resource to climate changes, its ***exposure*** to those changes, and its ***capacity to adapt*** to those changes (IPCC 2007)



Purpose of a vulnerability assessment:

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



# Assessing Exposure

Climate Variables	Trend	Score
Air temperature	▲	3
Water temperature	▲	3
Heat waves	▲	3
Precipitation	●	2
Coastal fog	▼	2-3
Soil moisture	▼	3
Drought	▲	3
Streamflow	▼▲	3
Sea level rise	▲	3
Wildfire	▲	2
Storms/flooding	▲	2

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



# Assessing Sensitivity



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

## Factors affecting sensitivity:

- Physical and biological effects of climate stressors and disturbance regimes
- Interactions between climate change and local non-climate stressors



# Assessing Adaptive Capacity

Measure of a resource's *ability to accommodate or cope* with climate change impacts with minimal disruption



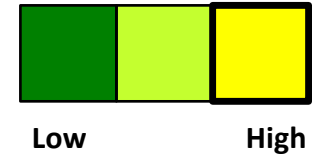
Photo by BLM (CC BY 2.0)

## Factors considered:

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

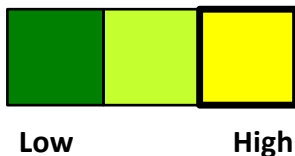


# Vulnerability Results: *Seeps and Springs*



## Exposure

- Precipitation
- ▲ Drought
- ▲ Wildfire
- ▲ Storms
- ▲ Flooding



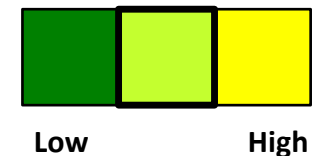
**High Impact**

## Sensitivity

- Reduced groundwater recharge
- Changes in spring discharge (e.g., drying)
- Altered plant productivity, survival, & composition
- Non-climate stressors:
  - Altered groundwater dynamics
  - Degraded water quality
  - Increased stress on plant communities

## Adaptive Capacity

- + High biological diversity
- + Resistant to temperature & drought
- + High public value
- Isolated communities
- Tied to static features
- Knowledge gaps



**Moderate AC**



# Relative Vulnerability: *Habitats*



Habitat	Vulnerability Score	Confidence Score
Oak woodlands	High	High
Rivers/streams/floodplains	High	High
Freshwater marshes/wetlands/ponds	High	Moderate
Seeps/springs	High	Moderate
Chaparral	Moderate	High
Mixed grasslands	Moderate	High
Coastal dunes/wet meadows/prairies	Moderate	Moderate
Coastal scrub	Moderate	Moderate
Mixed evergreen/montane hardwood forests	Moderate	Moderate
Coastal redwood forests	Moderate	Moderate



**Adaptive Capacity**

High

Mod

Low

**Low  
Vulnerability**

**Coastal  
redwood forest**

**Chaparral**

**Coastal scrub**

**Mixed grasslands**

**Mixed evergreen/montane  
hardwood forest**

**Freshwater marshes/  
wetlands/ponds**

**Rivers/streams/  
floodplains**

**Oak woodlands**

**Seeps/springs**

**Coastal wet  
meadows & prairies**

**High  
Vulnerability**

**Coastal dunes**

Low

Mod

High

**Sensitivity & Exposure**





# Relative Vulnerability: *Species/Species Groups*



Species/Species Group	Vulnerability Score	Confidence Score
Bats	High	High
Salamanders	High	High
Badger/burrowing owl	High	Moderate
California red-legged frog/SF garter snake	High	Moderate
Marbled murrelet	High	Moderate
Salmonids	High	Moderate
Butterflies	Moderate	Moderate
Wide-ranging mammals	Moderate	Moderate
Coyote brush	Low	High



**Adaptive Capacity**

High

Mod

Low

**Low  
Vulnerability**

**Coyote brush**

**Wide-ranging  
mammals**

**Butterflies**

**Bats**

**Salmonids**

**Burrowing Owl**

**Marbled murrelet**

**Badger**

**California red-  
legged frog**

**San Francisco  
garter snake**

Low

Mod

High

**Sensitivity & Exposure**



# Vulnerability Assessment Trends



## Climate Stressors

- Precipitation
- Soil moisture
- Drought
- Air temperature

## Disturbance Regimes

- Wildfire
- Storms/flooding

## Non-Climate Stressors

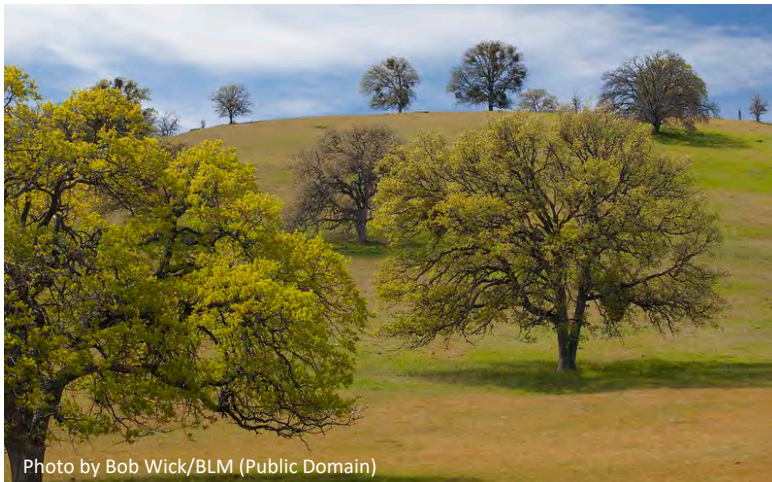
- Development
- Roads, highways, & trails
- Invasive species
- Livestock grazing
- Recreation



# Vulnerability Assessment Trends

## Factors that Enhance AC

- + Many resources are widely distributed
- + High species and physical diversity
- + High public value/societal support



## Factors that Undermine AC

- Habitat fragmentation and barriers to movement (e.g., roads)
- Low genetic diversity
- Limited management capacity (habitats) and ability (species)



# Vulnerability Assessment Products

<http://ecoadapt.org/workshops/midpen-adaptation>

WORKSHOP  
SUPPORT  
HOME PAGE



## Seeps and Springs

Climate Change Vulnerability Assessment for the Santa Cruz Mountains Climate Adaptation Project

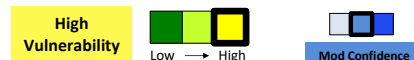
This document represents an initial evaluation of mid-century climate change vulnerability for seeps and springs in the Santa Cruz Mountains region based on expert input during an October 2019 vulnerability assessment workshop as well as information in the scientific literature.

### Habitat Description

Springs and seeps (i.e., low-discharge springs) are the physical locations where groundwater is discharged from aquifers to the Earth's surface<sup>1</sup>, with discharge rates varying seasonally depending on the depth and size of the supporting aquifers<sup>2</sup>. Deep aquifers are often confined or semi-confined, meaning that an impermeable layer of dirt, clay, and/or rock prevents water from seeping directly from the ground surface down into the aquifer below<sup>3</sup>. This results in longer delays in recharge and longer water residence time<sup>4</sup>. Shallow, unconfined aquifers experience more rapid recharge as water percolates from the surface directly into the aquifer<sup>4</sup>.

In the Santa Cruz Mountains region, seeps and springs are abundant in the middle to upper elevations of the mountain ranges, as well as along the coast. They often occur naturally near landslides, faults, anticlines, and other geologic features<sup>5</sup>. Others are created through human intervention in areas that would not otherwise have groundwater discharge to the surface<sup>5</sup>.

### Vulnerability Ranking



Seeps and springs are sensitive to climate stressors and disturbance regimes that alter groundwater recharge and discharge, including changes in patterns of precipitation and runoff, increased drought, altered wildfire regimes, and more frequent and intense storms and flooding. Non-climate stressors including groundwater extraction, surface water diversions, and livestock grazing can exacerbate habitat sensitivity to climate changes by altering groundwater dynamics, degrading water quality, and increasing stress on groundwater-dependent plant communities. Seeps and springs are distributed widely throughout California but are static and often isolated landscape features, reducing the potential for associated flora and fauna to shift their range in response to climate changes and disturbance. In general, seeps and springs are fairly resistant to stressors such as increased temperature, hydraulic flow changes, and drought, especially when they are connected with deep groundwater sources or large regional aquifers. However, climate-driven increases in groundwater withdrawals during dry periods can cause more rapid depletion than would otherwise occur. Multiple opportunities exist to adjust land-use practices and reduce non-climate impacts on seep and spring ecosystems, improving their ability to cope with climate impacts. These include reducing anthropogenic groundwater withdrawals and water diversions, managing grazing intensity, and mapping and monitoring seep and spring ecosystems.

## Reading & Resources

### Draft Vulnerability Assessments for Focal Habitats and Species:

#### Habitats

- Coastal dunes, wet meadows, and prairies
- Coastal scrub
- Chaparral shrublands
- Mixed grasslands
- Oak woodlands
- Mixed evergreen/montana hardwood forests
- Coastal redwood forests
- Rivers, streams, & floodplains
- Freshwater marshes, wetlands, and ponds
- Seeps and springs

#### Species

- American badger and western burrowing owl
- Bats

Peer reviewers needed!

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