SEEPS & SPRINGS

Climate Change Vulnerability and Adaptation Strategies for the Santa Cruz Mountain Region

Habitat Description

Seeps and springs are the physical locations where groundwater is discharged from aquifers to the Earth's surface, with discharge rates varying seasonally depending on the depth and size of the supporting aquifers. In the Santa Cruz Mountains region, seeps and springs are abundant and productive in the middle to upper elevations of the mountain ranges, and common but less productive along the coast. They often occur naturally near landslides, faults, anticlines, and other geologic features.

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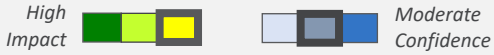
Habitat Vulnerability

Sensitivity & Exposure



Projected Changes	Trend
Precipitation/runoff	▲▼
Drought	▲
Wildfire	▲
Storms/flooding	▲

Potential impacts:

- Changes in the magnitude and timing of groundwater recharge, impacting spring hydrology and productivity, survival, and composition in adjacent plant communities
- Possible drying of springs during severe droughts
- Increased flooding in low-lying areas due to heavier precipitation events
- Removal of vegetation and increased risk of erosion and landslides following fires and severe floods

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

- *Groundwater extraction* and *surface water diversions* are associated with declines in spring discharge, decreased plant vigor, and limited water availability for wildlife, especially during periods of low precipitation/drought
- *Land-use conversion for residential/commercial development* impacts soil infiltration, runoff, and water quality (e.g., by introducing contaminants in runoff from impervious surfaces)
- *Livestock grazing* can compact soils, remove vegetation, and increase nutrient inputs, depending on grazing intensity; these impacts decrease groundwater recharge, increase runoff, and alter vegetation height and cover

Seeps and springs are sensitive to climate stressors and disturbance regimes that alter groundwater recharge and discharge, degrade water quality, and increase stress or mortality in groundwater-dependent plant communities.

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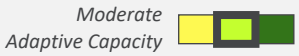
Adaptive Capacity



Intrinsic factors (i.e., inherent characteristics) that enhance or undermine adaptive capacity:

- ▲ Widely distributed in the state
- ▲ Relatively resistant to changes in temperature, hydraulic flow, and drought
- ▲ Biologically rich ecosystems, supporting many rare and/or endemic species
- ▼ Static, isolated landscape features, reducing the potential for species shifts in response to climate change and disturbances
- ▼ Groundwater withdrawals reduce resistance to periods of low precipitation and drought

Extrinsic factors (i.e., management potential) that enhance or undermine adaptive capacity:

- ▲ High public value and represent critical resources for humans and wildlife
- ▼ Little societal support for management
- ▼ Significant knowledge gaps exist (e.g., mapping)

Seeps and springs are naturally slow to respond to environmental changes, particularly where connected to deep groundwater sources or large aquifers. However, the isolated nature of these systems reduces their ability to recover from extreme events or habitat degradation.

Adaptation Strategies for Seeps and Springs

The scientific literature documents multiple opportunities to adjust land-use practices and reduce non-climate impacts on seep and spring ecosystems, improving their ability to cope with climate impacts.

ADAPTATION APPROACH	ADAPTATION STRATEGIES
Resistance strategies: Maintain current conditions by limiting change *Near-term approach*	• Manage grazing intensity to limit damage from livestock, and construct exclosures to keep livestock out of sensitive areas • Reduce anthropogenic groundwater withdrawals and water diversions to prevent the drying of springs
Resilience strategies: Accommodate some change while enabling a return to prior conditions *Near- to mid-term approach*	• Encourage the creation of irrigation districts to improve strategic management of where water is coming from* • Reintroduce beavers to improve landscape water storage and groundwater recharge*
Response strategies: Intentionally facilitate or direct adaptive change *Long-term approach*	• Identify and protect seeps and springs that may act as potential refugia for plants and animals in surrounding habitats (may increase support for habitat management and protection)*
Knowledge strategies: Gather information about climate impacts, and/or management effectiveness *Near- to long-term approach*	• Map and monitor seep and spring ecosystems to allow the use of adaptive management strategies designed to protect groundwater supplies and critical plant and wildlife habitat* • Identify opportunities to keep water in the system
Collaboration strategies: Coordinate management efforts and/or capacity across boundaries *Near- to long-term approach*	• Work with enforcement agencies to identify and eliminate instances of illegal take from springs* • Promote water conservation through collaborative agreements (e.g., water banking, water trading)*

** Future management strategies (not currently occurring)*

EcoAdapt™ Meeting the challenges of climate change

Further information and citations can be found in the source reports of the Santa Cruz Mountains Climate Adaptation Project, available online at http://ecoadapt.org/programs/awareness-to-action/santa-cruz-mountains.