Groundwater, Seep, and Spring Habitats

Climate Vulnerability Assessment and Adaptation Strategies for Maui, Lāna‘i, and Kaho‘olawe

HABITAT DESCRIPTION
Groundwater systems include freshwater lenses floating over saltwater on flank lavas and high-level or perched water impounded by low-permeability features, such as volcanic dikes. Groundwater flows toward the coast, discharging to streams, springs, and submerged marine seeps. Terrestrial perennial seeps and springs can be found along banks of severely incised streams and coastal rock faces. On Maui, springs also emerge from perched aquifers on Ke‘anae Point.

HABITAT VULNERABILITY
Groundwater, seeps, and springs are sensitive to factors that reduce groundwater recharge and degrade water quality. Tropical storms promote recharge, while shifts in precipitation amount/timing and drought reduce recharge, and along with sea level rise, increase vulnerability to saltwater intrusion. Groundwater recharge and storage are also negatively affected by urban water withdrawals and water diversions. Comparatively, agricultural irrigation promotes groundwater recharge, but irrigation contributions have been declining over the past several decades. Agricultural and urban runoff degrade groundwater quality. Groundwater management is supported by many different agencies, but these habitats compete for water with many human uses, and conflicts may increase in a drier climate.

PROJECTED FUTURE CHANGES

<table>
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<tr>
<th>POTENTIAL IMPACTS ON GROUNDWATER, SEEP, AND SPRING HABITATS</th>
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<td>• Reduced groundwater recharge and storage, although recharge rates can also be impacted by other factors (e.g., agricultural irrigation)</td>
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<td>• Increased likelihood of drying springs</td>
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<td>• Increased vulnerability to saltwater intrusion</td>
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Increased frequency & strength of tropical storms/hurricanes
• Increased groundwater recharge due to heavy precipitation

Increased air temperatures
+2.0°C (3.6°F) to +3.5°C (6.3°F) by 2100
• Reduced groundwater recharge due to increased evaporation, particularly when paired with precipitation declines

Sea level rise
+0.4 m (1.3 ft) to +3.3 m (10.8 ft) of sea level rise by 2100
• Increased saltwater intrusion and associated groundwater salinity
• Reduced/ altered dispersal patterns of aquatic organisms due to increased salinity

Drivers of Habitat Vulnerability
• Climatic factors and disturbance regimes: Precipitation amount & timing, drought, tropical storms/hurricanes, air temperature, sea level rise
• Non-climate factors: Residential & commercial development, water diversions, pollution & poisons, agriculture & aquaculture

ADAPTIVE CAPACITY
Factors that enhance adaptive capacity:
+ Managing water consumption and removing historical water diversions may reduce risk of saltwater intrusion
+ Groundwater system management supported by many different governmental agencies
+ Valued by the public for drinking/potable water supplies, as well as for agricultural, commercial, traditional, recreational, and subsistence uses

Factors that undermine adaptive capacity:
- Groundwater extent and integrity threatened by population growth and increasing water withdrawals
- Relatively little is known about these systems
- Low-moderate societal support for groundwater conservation/management
- Competing interests include development, agriculture, and other off-stream uses; conflicts will likely increase if climate change reduces water supply
# Adaptation Strategies for Groundwater, Seep, and Spring Habitats

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<tr>
<th>Types of Adaptation Approaches</th>
<th>Adaptation Strategy</th>
<th>Specific Action</th>
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| **Resistance**: Prevent climate change from affecting a resource.  
*Near-term approach* | Manage invasive species | • Use fencing in critical watersheds to exclude ungulates from upland forest areas  
• Maintain and enhance groundwater quality and quantity  
| | | • Adopt well source protection ordinances |
| **Resilience**: Help resources weather climate change by avoiding the effects of or recovering from changes  
*Near- to mid-term approach* | Protect forests to increase recharge and water retention | • Support healthy native forests through land acquisition and plant restoration |
| **Response**: Intentionally accommodate change and adaptively respond to variable conditions  
*Long-term approach* | Facilitate transition of species into new areas as climate regimes shift | • Prioritize the planting of native species that thrive in a wide variety of conditions (e.g., generalists, resilient species) |
| **Knowledge**: Gather information about climate impacts and/or management effectiveness in addressing climate challenges  
*Near- to long-term approach* | Monitor pollutants to protect water quality | • Monitor point- and non-point source pollutants associated with agriculture and development  
• Monitor and regulate salinity and other indicators of water quality in wells and groundwater |
| **Collaboration**: Coordinate efforts and capacity across landscapes and agencies  
*Near- to long-term approach* | Increase collaborative efforts to conserve streams and watersheds | • Expand watershed conservation to lower elevations by enhancing watershed partnerships and seeking legislative changes at the state and local levels |

**Likelihood of reducing vulnerabilities**

| Low F/Low E | Expand watershed conservation to lower elevations by enhancing watershed partnerships and seeking legislative changes |
| Low F/High E | Adopt well source protection ordinances  
Prioritize planting native species that thrive in a wide variety of conditions |
| High F/Mod E | Use fencing in critical watersheds to exclude ungulates from upland forests  
Support healthy native forests through land acquisition and plant restoration |
| High F/High E | Monitor point- and non-point source pollutants associated with agriculture and development  
Monitor and regulate salinity and other indicators of water quality in wells and groundwater |

**FEASIBILITY**

**Ease of action implementation**

Further information and citations can be found in the Hawaiian Islands Climate Vulnerability and Adaptation Synthesis and other products available online at [www.bit.ly/HawaiiClimate](http://www.bit.ly/HawaiiClimate).


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