Groundwater, Seep, and Spring Habitats

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

EcoAdapt™

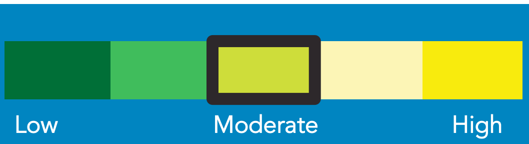
PACIFIC ISLANDS
CLIMATE CHANGE
COOPERATIVE

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.



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

PROJECTED FUTURE CHANGES	POTENTIAL IMPACTS ON GROUNDWATER, SEEP, AND SPRING HABITATS
Changes in **precipitation**; variable **drought risk** *(increased for low- and mid-elevation leeward areas, decreased for mid-elevation windward areas)*	• Reduced groundwater recharge and storage, although recharge rates can also be impacted by other factors (e.g., agricultural irrigation) • Increased likelihood of drying springs • Increased vulnerability to saltwater intrusion
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

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

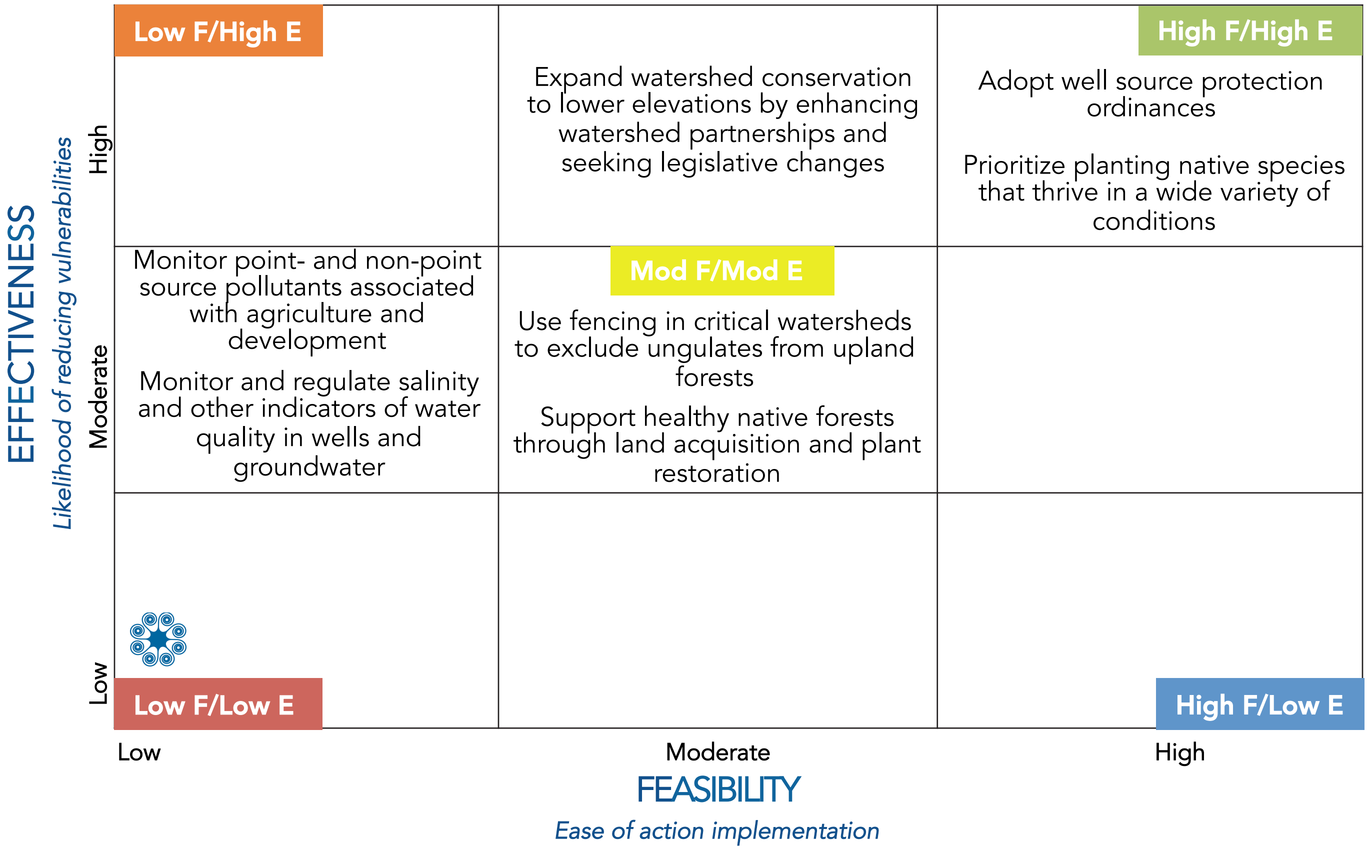
– Relatively little is known about these systems

– 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

Types of Adaptation Approaches	Adaptation Strategy	Specific Action
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



	Low	Moderate	High
High		Expand watershed conservation to lower elevations by enhancing watershed partnerships and seeking legislative changes	Adopt well source protection ordinances Prioritize planting native species that thrive in a wide variety of conditions
Moderate	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	Use fencing in critical watersheds to exclude ungulates from upland forests Support healthy native forests through land acquisition and plant restoration	
Low			

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.

Reynier WA, Gregg RM. 2018. Groundwater, Seep, and Spring Habitats: Vulnerability and Adaptation Brief for Maui, Lāna‘i, and Kaho‘olawe. EcoAdapt, Bainbridge Island, WA.
Produced in cooperation with the Pacific Islands Climate Change Cooperative, with funding from the U.S. Fish and Wildlife Service.