

Alpine & Subalpine Habitats

Climate Vulnerability Assessment and Adaptation Strategies for Maui, Lānaʻi, and Kahoʻolawe

HABITAT DESCRIPTION

Alpine and subalpine habitats are found in high-elevation areas of Haleakalā on Maui. These habitats mostly lie above the mean height of the trade wind inversion, and so are arid with very little precipitation or fog. Alpine communities are found above the tree line up to the summit of Haleakalā at 3,055 m (10,023 ft); they are dry and semi-barren, with sparse, highly-specialized vegetation such as the Haleakalā silversword. Subalpine communities lie between 2,000 and 3,000 m (6,560 to 10,000 ft) in elevation, and may consist of forests, shrublands, and grasslands. Dominant trees include māmane (*Sophora chrysophylla*), naio (*Myoporum sandwicense*), and ʻōhiʻa lehua (*Metrosideros polymorpha*).



HABITAT VULNERABILITY

Alpine and subalpine habitats are typically dry and are most sensitive to factors that increase water stress. Because vegetation is slow to recover following disturbance, subalpine forests and shrublands are particularly sensitive to wildfire. In general, non-climate stressors have a low impact on these habitats; however, invasive species and recreation can degrade habitats and alter native species composition. These habitat types on Maui are protected but very limited in extent, with little ability to shift upslope into higher-elevation areas. Although these habitats are highly valued, the eventual loss of refugia may make it difficult for many endemic and highly specialized species to survive.



Drivers of Habitat Vulnerability

- **Climatic factors and disturbance regimes:** Precipitation, drought, wind/circulation, soil moisture, extreme precipitation events, wildfire
- **Non-climate factors:** Invasive species, recreation

ADAPTIVE CAPACITY

Factors that enhance adaptive capacity:

- + Most alpine/subalpine habitat is protected as conservation area, resulting in high structural/functional integrity
- + Many highly specialized and endemic species
- + Some species (e.g., Haleakalā silversword, ʻōhiʻa) have adaptations that enhance drought resilience
- + Highly valued by the public and receives moderate-high societal support
- + Many constituency groups are effective and engaged in habitat conservation

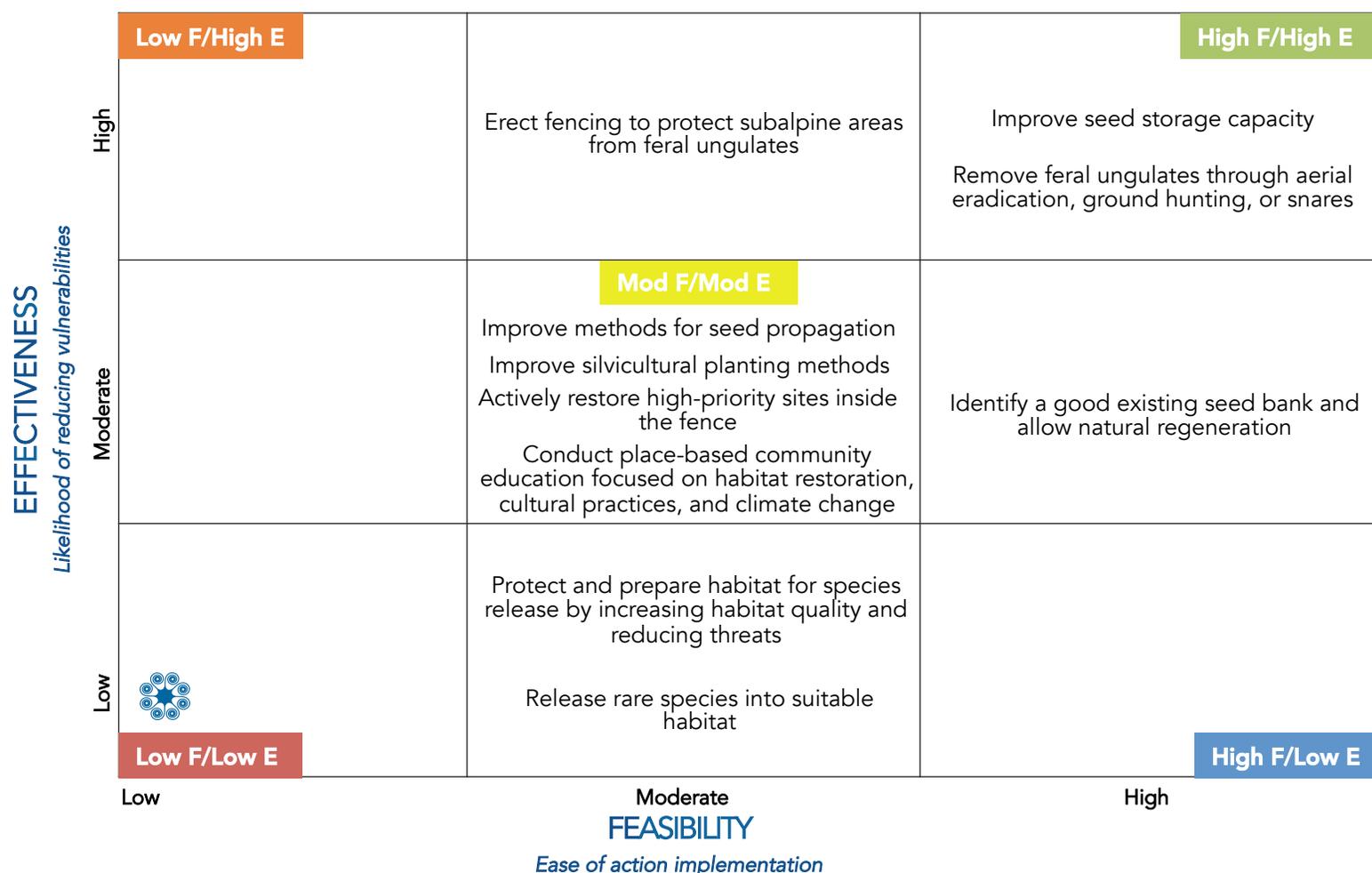
Factors that undermine adaptive capacity:

- Upslope habitat migration is unlikely for subalpine habitats and impossible for alpine habitats
- Slow recovery from disturbances due to slow plant growth and low seedling recruitment
- Resistance to climate impacts largely dependent on ongoing habitat protection and management
- Highly specialized species are vulnerable to water stress and eventual loss of refugia

PROJECTED FUTURE CHANGES	POTENTIAL IMPACTS ON ALPINE & SUBALPINE HABITATS
Reduced precipitation and soil moisture	<ul style="list-style-type: none"> • Native plant mortality due to water stress, though some species exhibit traits that increase drought tolerance • Significant downward movement of the tree line under drier conditions; slight upslope movement under wetter conditions
Increased drought risk	<ul style="list-style-type: none"> • Increased native plant mortality with possible extirpation of rare species
Changes in wind and circulation 8-9% increase in the frequency of the TWI	<ul style="list-style-type: none"> • Increased water stress in native vegetation • Shifts in species distribution at high-elevation sites (e.g., subalpine forests)
Increased air temperatures +3.0°C (5.4°F) to +3.5°C (6.3°F) at elevations over 3,000 m (10,000 ft)	<ul style="list-style-type: none"> • Possible short-term increases in productivity for temperature-limited species, followed by declines as air temperature crosses this threshold and negatively impacts growth and survival • Altered pollination/dispersal via effects on ground-dwelling insects
Uncertain change in frequency and intensity of extreme precipitation events	<ul style="list-style-type: none"> • Increased soil moisture may benefit native plants experiencing water stress • Increased erosion and potential plant mortality
Increased wildfire	<ul style="list-style-type: none"> • Increased invasive grass colonization, perpetuating shifts in wildfire • Increased erosion

ADAPTATION STRATEGIES FOR ALPINE & SUBALPINE HABITATS

Types of Adaptation Approaches	Adaptation Strategy	Specific Action
Resistance: Prevent climate change from affecting a resource <i>Near-term approach</i>	Manage invasive species	<ul style="list-style-type: none"> Erect fencing to protect subalpine areas from feral ungulates Remove feral ungulates through aerial eradication, ground hunting, or snares
Resilience: Help resources weather climate change by avoiding the effects of or recovering from changes <i>Near- to mid-term approach</i>	Maintain and augment native species populations	<ul style="list-style-type: none"> Identify a good existing seed bank and allow natural regeneration Actively restore high-priority sites inside the fence, considering surrogate species that may be tolerant of future climate conditions
Response: Intentionally accommodate change and adaptively respond to variable conditions <i>Long-term approach</i>	Use assisted colonization to restore rare species (e.g., birds)	<ul style="list-style-type: none"> Protect and prepare habitat for rare species release by increasing habitat quality and reducing threats Release rare species into suitable habitat and monitor dispersal, survival, and reproductive success
Knowledge: Gather information about climate impacts and/or management effectiveness in addressing climate challenges <i>Near- to long-term approach</i>	Improve silvicultural practices for priority species	<ul style="list-style-type: none"> Improve seed storage capacity Improve methodology for seed propagation Improve silvicultural planting methods (i.e. seed collection, composition, spacing)
Collaboration: Coordinate efforts and capacity across landscapes and agencies <i>Near- to long-term approach</i>	Increase direct community restoration	<ul style="list-style-type: none"> Conduct place-based community education, organizing, management, and action focused on habitat restoration, cultural practices, and climate change impacts



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.

Hilberg LE, Gregg RM. 2018. Alpine & Subalpine 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.