



Cultural Coastal Habitats

Climate Change Adaptation Summary for Kauaʻi

An Important Note About this Document: This document represents an initial effort to identify adaptation actions for cultural coastal habitats on Kauaʻi based on stakeholder input and existing information. Specifically, the information presented below comprises stakeholder input,¹ peer-review comments and revisions, and relevant examples from the literature or other similar efforts. The aim of this document is to expand understanding of possible adaptation actions for Kauaʻi cultural coastal forest habitats in response to climate change.

Habitat Vulnerability



Cultural coastal habitats on Kauaʻi were evaluated within four distinct groups: salt ponds, fishponds, iwi, and kalo.

Overall cultural coastal habitats were evaluated as having moderate vulnerability to climate change due to moderate-high sensitivity to climate and non-climate stressors, moderate-high exposure to projected future climate changes, and moderate adaptive capacity. Cultural coastal habitats are vulnerable to changes in climate factors and disturbances that affect water availability and quality and increase pollutants and sediment delivery (e.g., saltwater intrusion, increased water temperature, changes in precipitation and streamflow, more drought, tropical storms, wind, and flooding). Sea level rise and associated coastal flooding and erosion are likely to alter habitat extent, and disturbances may also destroy structures (e.g., tropical storms, wind, flooding) or contribute to injury or mortality in crops and fish stocks (e.g., insects, disease). Non-climate stressors, including development, invasive trees/shrubs, recreation, and pollution/poisons, contribute to cultural coastal habitat loss and degradation by damaging structures, increasing sedimentation, introducing nutrients and contaminants, and allowing the establishment of invasive species. Almost all salt cultivation within the state and over half the area of kalo cultivation occur on Kauaʻi, although the extent of all cultural coastal habitats is much reduced. These habitat types receive relatively low public and societal support, but many constituency groups also influence support and some habitat areas have been protected. The right to continue traditional practices has also been recognized by the state constitution, but enforcement of these rights is low and increased public education and support is necessary for successful habitat management and conservation.

Adaptation Strategies and Actions

Table 1 presents a summary of possible adaptation strategies and actions for Kauaʻi cultural coastal habitats, and consists of stakeholder input during an adaptation workshop as well as additional options from the literature or other similar efforts. Stakeholders identified ways in which current management actions could be modified to reduce habitat vulnerabilities as well as future management actions that are not currently implemented but could be considered for future implementation.

Resilient management requires implementing a range of adaptation options within these different categories in order to achieve short-, mid-, and long-term resilience. These adaptation strategies and actions can generally be grouped according to one of five categories:

1. **Resistance.** These strategies can help to prevent the effects of climate change from reaching or affecting a resource.
2. **Resilience.** These strategies can help a resource withstand the impacts of climate change by avoiding the effects of or recovering from changes.

¹ This information was gathered during a climate adaptation planning workshop in June 2017 (<http://www.ecoadapt.org/workshops/kauaiadaptationworkshop>). 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.

3. **Response.** These strategies intentionally accommodate change and/or enable resources to adaptively respond to changing and new conditions.
4. **Knowledge.** These strategies are aimed at gathering more information about climatic changes, impacts, or the effectiveness of management actions in addressing climate change.
5. **Collaboration.** These strategies may help coordinate efforts and/or capacity across landscapes and agencies.

Table 1. Summary of possible adaptation options for Kaua'i cultural coastal habitats. All strategies and actions were identified by Kaua'i workshop participants unless noted otherwise. Adaptation approaches are classified by implementation timeframes (*Near-term*: 0-5 years; *Mid-term*: 5-20 years; *Long-term*: >20 years).

Adaptation Approach	Adaptation Strategy	Specific Adaptation Actions
Resistance <i>Near-term approach</i>	Manage invasive species	<ul style="list-style-type: none"> • Increase biosecurity • Remove hau and mangroves
	Perpetuate cultural knowledge, practices, and sites (e.g., landscapes, traditions, and values)	<ul style="list-style-type: none"> • Identify climate-informed processes for conservation practices in vulnerable cultural sites
Resilience <i>Near- to mid-term approach</i>	Maintain/improve water quantity and quality	<ul style="list-style-type: none"> • Increase watershed management planning • Manage runoff (stormwater, wastewater, nutrients) in areas affected by human activity
	Perpetuate cultural knowledge, practices, and sites (e.g., landscapes, traditions, and values)	<ul style="list-style-type: none"> • Identify where cultural coastal sites are and how best preserve them into the future • Investigate whether iwi should be re-interred in more resilient areas or left in place • Ensure cultural practitioners have ownership over what kind and detail of information is shared about important cultural coastal resources (e.g., site locations)
Response <i>Long-term approach</i>	Anticipate and facilitate habitat migration	<ul style="list-style-type: none"> • Plan for and facilitate inland/upland habitat migration • Facilitate managed retreat of infrastructure and human communities • Investigate the utility of maintaining mangroves if they can effectively buffer sea level rise and flooding impacts • Implement living shorelines and green infrastructure • Limit development in inland/upland areas where coastal habitats may migrate
Knowledge <i>Near- to long-term approach</i>	Prepare for sea level rise impacts	<ul style="list-style-type: none"> • Map sea level rise impacts and future shoreline position
	Perpetuate cultural knowledge, practices, and sites (e.g., landscapes, traditions, and values)	<ul style="list-style-type: none"> • Research historic conditions and trends in cultural practices (e.g., environmental baseline conditions) to inform current management
Collaboration <i>Near- to long-term approach</i>	Support linkages between cultural practitioners	<ul style="list-style-type: none"> • Increase cooperation and knowledge sharing between cultural communities • Use local stories about climate change impacts to encourage collaboration and on-the-ground action

Adaptation Approach	Adaptation Strategy	Specific Adaptation Actions
	Create dialogue between cultural practitioners and natural resource managers	<ul style="list-style-type: none"> Establish and empower community-identified liaisons to help with conservation goals Increase cultural participation in tracking environmental and climatic change (e.g., host community workshops teaching how to kilo [observe] in different sites, reinstate volunteer work days to help people reconnect to the land)

Table 2 identifies key Kauaʻi cultural coastal habitat vulnerabilities that may be reduced and/or addressed by various adaptation actions. Linking vulnerabilities to adaptation options can help managers decide which actions to implement and aid prioritization based on multiple factors (e.g., habitat type, observed or projected changes, ecosystem service). However, when selecting adaptation actions for implementation, it is also important to consider secondary effects on other resources, both positive and negative. For example, fencing may benefit native forest ecosystems by limiting ungulate access and activity, but may increase ungulate stress on other habitats. For more information about cultural coastal habitat adaptation strategies and actions developed by workshop participants, including where and how to implement adaptation actions, implementation timeframe, collaboration and capacity required, and secondary effects on other resources (both positive and negative), please see the report *Hawaiian Islands Climate Vulnerability and Adaptation Synthesis*.

Table 2. Key vulnerabilities of Kauaʻi cultural coastal habitats linked to specific adaptation actions and management activities (linkages are based on expert opinion); implementation of adaptation actions (central column) may help to directly reduce and/or address the impacts of identified climate and non-climate stressors and disturbance regimes (right columns). Actions highlighted in **red** represent adaptation strategies that enhance resistance, those highlighted in **orange** promote resilience, and those highlighted in **green** facilitate response. Adaptation actions aimed at increasing knowledge and collaboration are not included in this table as they address vulnerability indirectly. Adaptation actions listed in this table include those identified by stakeholders, in the scientific literature, and in other similar efforts.

Management Activity	Adaptation Actions	Climate Stressors						Disturbance Regimes		Non-Climate Stressors			
Habitat Management Activities	Increase biosecurity								✓		✓		
	Remove hau and mangroves										✓		
	Manage runoff (stormwater, wastewater, nutrients) in areas affected by human activity						✓	✓		✓			✓
	Investigate the utility of maintaining mangroves if they can effectively buffer sea level rise and flooding impacts	✓					✓						
	Implement living shorelines and green infrastructure	✓					✓	✓		✓			
Land Use Planning Activities	Identify climate-informed processes for conservation practices in vulnerable cultural sites	✓					✓	✓	✓	✓	✓	✓	✓
	Increase watershed management planning			✓	✓			✓		✓			
	Identify where cultural coastal sites are and how best preserve them into the future	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Investigate whether iwi should be re-interred in more resilient areas or left in place	✓								✓			
	Ensure cultural practitioners have ownership over what kind and detail of information is shared about important cultural coastal resources (e.g., site locations)									✓		✓	
	Plan for and facilitate inland/upland habitat migration	✓	✓		✓								
	Facilitate managed retreat of infrastructure and human communities	✓								✓			
	Limit development in inland/upland areas where coastal habitats may migrate	✓								✓			

In addition to directly reducing vulnerabilities (Table 2), some adaptation actions may indirectly address vulnerabilities. For example, planting resilient native species that are generalists increase the likelihood that the invasive species will not be able to successfully outcompete with natives.

Two other important considerations when selecting adaptation actions for implementation include feasibility (action capable of being implemented) and effectiveness (action reduces vulnerability; Figure 1). An adaptation action with high feasibility has no obvious barriers and a high likelihood of implementation, whereas an action with low feasibility has obvious and/or significant barriers to implementation that may be difficult to overcome. An adaptation action with high effectiveness is very likely to reduce associated vulnerabilities (listed in Table 2) and may benefit additional management goals or resources, whereas an action with low effectiveness is unlikely to reduce vulnerability and may have negative impacts on other resources.

Feasibility of Implementing the Action	Action Effectiveness at Reducing Vulnerabilities
<ul style="list-style-type: none"> <i>High</i>: There are no obvious barriers and it has a high likelihood of being implemented <i>Moderate</i>: It may be possible to implement the action, although there may be challenges or barriers <i>Low</i>: There are obvious and/or significant barriers to implementation that may be difficult to overcome 	<ul style="list-style-type: none"> <i>High</i>: Action is very likely to reduce vulnerability and may benefit additional goals or habitats <i>Moderate</i>: Action has moderate potential to reduce vulnerability, with some limits to effectiveness <i>Low</i>: Action is unlikely to reduce vulnerability

Figure 1. Description of action feasibility and effectiveness rankings.

Figure 2 plots adaptation actions listed in Table 1 according to feasibility and effectiveness (rankings described in Figure 1). Figure 2 can help managers prioritize actions for implementation (e.g., actions with high feasibility and high effectiveness), better target management efforts toward specific challenges (e.g., actions with low or moderate feasibility but high effectiveness), and/or evaluate whether to proceed with implementation (e.g., actions with high feasibility but low effectiveness). For the latter two purposes, managers may consider the following questions:

- **Low or Moderate Feasibility/High Effectiveness Actions:** What steps can be taken to increase the likelihood of this action being implemented in the future?
 - *Example:* Would improving public outreach and education or enhancing public/private collaboration facilitate increased management access and activity on private lands (e.g., to remove invasive species)?
- **High Feasibility/Low or Moderate Effectiveness Actions:** Does this action still make sense given projected climate changes and impacts?
 - *Example:* If conditions are projected to become drier, should groundwater pumping still continue to support lowland wetland hydrology?

Alternatively, there may be some actions that do not reduce vulnerability directly but could provide important information, tools, or support to address vulnerability down the line. For example, actions aimed at increasing knowledge through monitoring or modeling could provide key information for future restoration activities (e.g., creating detailed species genetic profiles to select genetically and ecologically suitable plant species for future conditions). Managers may want to weigh the costs and benefits of implementing actions with the timeframe required to reduce vulnerability directly. Additionally, actions focused on coordination and collaboration may not directly address vulnerabilities, but these remain important steps toward better planning and management.

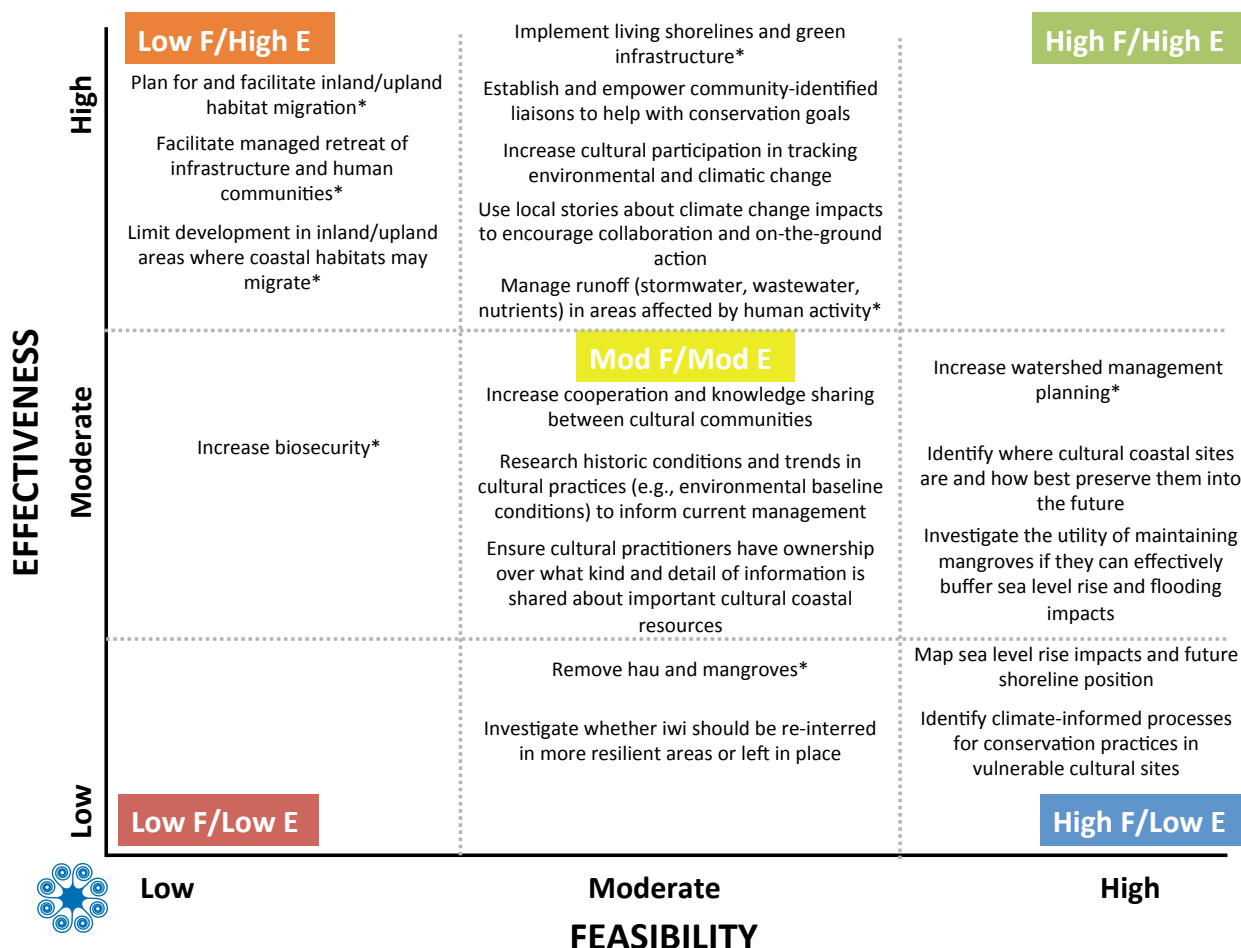


Figure 2. Kaua'i cultural coastal habitat adaptation actions plotted according to implementation feasibility (action capable of being implemented) and effectiveness (action reduces vulnerability). Those actions having high feasibility and effectiveness appear in the upper right corner and those actions having low feasibility and effectiveness appear in the bottom left corner. An asterisk (*) denotes adaptation actions evaluated for feasibility and effectiveness by workshop participants. All other adaptation action evaluations are based on expert opinion.

Lastly, it is important to consider long-term consequences of implementing adaptation actions. One way to evaluate this is to consider how easy it would be to reverse a management action once it has been implemented in case of unintended consequences. When considering action reversibility, managers should consider cost, personnel time, overall time required to reverse an action, and other relevant factors. For example, it would likely be easy to reverse an action focused on altered outplanting timing; outplanting timing could simply be changed to a more favorable time. Alternatively, it would likely be hard to reverse the successful introduction of a new biocontrol agent, requiring significant personnel time and funding. Generally, actions involving infrastructure installation, policy or legislative change, or new species introductions may be moderately difficult or hard to reverse.

Table 3 lists adaptation actions identified in Table 1 according to ease of reversibility, as well as feasibility and effectiveness. This table can help managers evaluate whether to proceed with implementation (e.g., easily reversible actions) and/or identify actions that may need more research, small-scale testing, careful planning and implementation, and/or heightened adaptive management (e.g., moderately difficult or hard to reverse actions).

Table 3. Kauaʻi cultural coastal habitat adaptation actions listed according to ease of reversibility, as well as feasibility and effectiveness. Actions that have high feasibility/effectiveness and are easy to reverse appear at the top of the list, and actions that have low feasibility/effectiveness and are hard to reverse appear at the bottom of the list. All adaptation action evaluations are based on workshop participant and expert opinion.

Adaptation Action	Feasibility	Effectiveness	Reversibility
Manage runoff (stormwater, wastewater, nutrients) in areas affected by human activity	High	Moderate	Easy
Implement living shorelines and green infrastructure	High	Moderate	Moderate
Identify where cultural sites are and how best preserve them into the future	High	Moderate	Moderate
Investigate the utility of maintaining mangroves if they can effectively buffer sea level rise and flooding impacts	High	Moderate	Easy
Use local stories about climate change impacts to encourage collaboration and on-the-ground action	High	Moderate	Moderate
Establish and empower community-identified liaisons to help with conservation goals	High	Moderate	Moderate
Increase cultural participation in tracking environmental and climatic change	Moderate	High	Moderate
Increase watershed management planning	High	Low-Moderate	Easy
Identify climate-informed processes for conservation practices in vulnerable cultural sites	High	Low	Moderate
Map sea level rise impacts and future shoreline position	High	Low	Hard
Limit development in inland/upland areas where coastal habitats may migrate	Low	High	Moderate
Plan for and facilitate inland/upland habitat migration	Low	High	Hard
Facilitate managed retreat of infrastructure and human communities	Low	High	Hard
Increase cultural participation in tracking environmental and climatic change (e.g., host community workshops teaching how to kilo [observe] in different sites, reinstate volunteer work days to help people reconnect to the land)	Moderate	High	Moderate
Ensure cultural practitioners have ownership over what kind and detail of information is shared about important cultural coastal resources (e.g., site locations)	Moderate	Moderate	Moderate
Research historic conditions and trends in cultural practices (e.g., environmental baseline conditions) to inform current management	Moderate	Moderate	Moderate
Increase cooperation and knowledge sharing between cultural communities	Moderate	Moderate	Hard
Investigate whether iwi should be re-interred in more resilient areas or left in place	Moderate	Low	Moderate
Remove hau and mangroves	Moderate	Low	Hard
Increase biosecurity	Low	Moderate	Easy

This document presents a range of adaptation options available for Kauaʻi cultural coastal habitats. When applying adaptation principles in existing management frameworks, general best practices include:

- ✓ Utilizing a range of adaptation categories to promote short-, mid-, and long-term resilience.

- ✓ Thinking critically about which climate vulnerabilities an action can directly address versus those it may address indirectly.
- ✓ Identifying where opportunities overlap (e.g., actions that address multiple vulnerabilities or benefit multiple resources), and being cognizant of actions that could create detriments to other resources.
- ✓ Prioritizing actions for implementation based on 1) how effective an action will be in reducing identified vulnerabilities; 2) how feasible implementing the action will be, and; 3) how easy it would be to reverse an action in case of unintended consequences.

Recommended Citation

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