Southern California Riparian Habitats

Climate Change Adaptation Actions Summary

An Important Note About this Document: *This document represents an initial effort to identify adaptation actions for riparian habitats in southern California based on stakeholder input and existing information. Specifically, the information presented below comprises stakeholder input during a two-day adaptation workshop, 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 southern California riparian habitats in response to climate change.*

Riparian Habitat Vulnerability

Moderate Vulnerability

The relative vulnerability of riparian habitats in southern California was evaluated to be moderate by habitat experts due to moderate-high sensitivity to climate and non-climate stressors, high exposure to future climate changes, and moderate adaptive capacity. Within arid and semi-arid regions such as southern California, riparian habitats are critically sensitive to changes in hydrologic and flooding regimes, which influence the amount, source, and duration of water within a system. Habitats that rely solely on precipitation are most sensitive to changes in the amount or timing of rain and snow, while groundwater-dependent systems such as springs may be less immediately responsive to changes in water availability. Drought conditions have widespread effects on all ecosystems and may shift species composition towards vegetation that can tolerate drier conditions. Severe flooding can cause erosion and channel entrenchment that may alter habitat structure and function, and wildfire greatly increases the risk of flash flooding and debris flows. Climate vulnerabilities in riparian habitats are further exacerbated by habitat degradation or loss due to human activities. Many riparian habitats have already been lost or heavily degraded by factors that alter their hydrological regime, including development and grazing. Although riparian habitats are adapted to variable conditions as a whole, degraded systems may be unable to recover from disturbance and management intervention may be needed to restore normal system processes (e.g., flooding regimes and sediment transport). Riparian habitats support very high numbers of endemic and threatened/endangered species due to their unique conditions and isolated nature. They provide valuable ecosystem services including the provision of clean water, flood control, and sediment transport.

Adaptation Strategies and Actions

Table 1 presents a summary of possible adaptation strategies and actions for riparian 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.

Adaptation strategies and actions are grouped according to one of five categories:

1. **Enhance Resistance**. These strategies can help to prevent the effects of climate change from reaching or affecting a resource.
2. **Promote Resilience**. These strategies can help a resource withstand the impacts of climate change by avoiding the effects of or recovering from changes.
3. **Facilitate Transition (or Response)**. These strategies intentionally accommodate change and/or enable resources to adaptively respond to changing and new conditions.

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4. **Increase Knowledge**. These strategies are aimed at gathering more information about climate changes, impacts, or the effectiveness of management actions in addressing climate change.
5. **Engage Coordination**. These strategies may help coordinate efforts and/or capacity across landscapes and agencies.

Table 1. Summary of possible adaptation options for riparian habitats.

Adaptation Category	Adaptation Strategy	Specific Adaptation Actions
Enhance resistance	Reset tree succession by managing disturbance in meadows	• Use low-density grazing to prevent woody plant encroachment and reduce non-native herbaceous species[1]
	Preserve native riparian habitat and maintain habitat connectivity	• Establish wilderness areas, focusing on intact riparian habitat[1] • Use vegetation to increase shading of riparian habitat and maintain cool, wet areas[3]
	Reduce the impact of public use and infrastructure	• Redesign trail system infrastructure to minimize impacts from trails in popular areas[1] • Barricade roads as needed to protect riparian systems[1] • Upgrade road crossings (e.g., install higher-capacity culverts) in areas that are prone to sedimentation and/or provide habitat for sensitive species[2] • Assess the location of roads and consider removing those within sensitive riparian systems[2]
	Manage grazing to reduce impacts on riparian vegetation and soil structure	• Focus grazing on non-native species in spring and prevent grazing on native species in summer[3] • Build livestock exclosures to protect riparian habitats that are easily damaged by grazing[3] • Implement moderate grazing around vernal pools to maintain vernal pool hydrology[4]
	Reduce water extraction from springs	• Decrease the number of permits for water extraction[1] • Do not renew expired permits for water extraction[1]
	Reduce impact of invasive species	• Remove invasive, water-consuming plants[1] • Manage invasive species that may increase during drought events (e.g., grasses, bullfrogs)[1]

[1] Denotes adaptation action identified by workshop participants.
[2] Halofsky, J. E., Peterson, D. L., O'Halloran, K. A., & Hawkins Hoffman, C. (Eds.). (2011). *Adapting to climate change at Olympic National Forest and Olympic National Park* (No. Gen. Tech. Rep. PNW-GTR-844). Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.
[3] Actions were sourced from the Climate Adaptation Project for the Sierra Nevada and/or the Northern Rockies Adaptation Partnership.
[4] Pyke, C. R., and J. Marty. (2005). Cattle grazing mediates climate change impacts on ephemeral wetlands. *Conservation Biology 19*:1619–1625.

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Adaptation Category	Adaptation Strategy	Specific Adaptation Actions
Promote resilience	Identify and restore key ecosystem functions	• Restore floodplain function by establishing setbacks, stabilizing banks and headcuts, and employing plug-and-pond techniques to support current and future hydrology[3]
	Increase floodplain resilience to high peak flows and erosion	• Remove or modify infrastructure to allow channel migration within the floodplain[3]
	Increase habitat heterogeneity to support species diversity	• Enhance breeding sites by providing microhabitat structure (e.g., woody debris) for nesting and egg deposition[3]
Facilitate transition	Establish local seed banks for future restoration projects	• Collect seeds from plants that have high value to wildlife and will be viable in the future[1] • Collect seeds from various locations and elevation bands, prioritizing species that are expected to tolerate future climate conditions[1] • Perform re-growth experiments to ensure that proper habitat restoration techniques are being used[1]
	Support species' survival under changing climate conditions	• Focus amphibian conservation activities in areas identified as climate refugia and/or areas that may be suitable habitat in the future[3] • Explore the potential for assisted translocation of obligate riparian species to suitable future habitat[5] • Protect networks of riparian habitat to create corridors for wildlife movement[6]
Increase knowledge	Improve understanding of the spatial and temporal connection between surface flows and groundwater in order to increase water residence time	• Map water sources and aquifers to understand spatial and temporal connections between surface flows and groundwater[3]
	Prioritize springs for protection and monitoring	• Map known springs and land cover type in order to prioritize protection[1] • Monitor the water level in springs to detect changes over time[1]
	Prioritize the protection of riparian habitat and monitor the effects of changing climate conditions	• Rank the vulnerability of groundwater-dependent systems[1] • Map riparian habitat, climate trends and 50-year climate projections, surrounding native vegetation, and historical species ranges[1]

[5] Millar, C. I., Stephenson, N. L., & Stephens, S. L. (2007). Climate change and forests of the future: managing in the face of uncertainty. *Ecological Applications*, *17*(8), 2145–2151.

[6] Lawler, J. J., Tear, T. H., Pyke, C., Shaw, R. M., Gonzalez, P., Kareiva, P., … Pearsall, S. (2010). Resource management in a changing and uncertain climate. *Frontiers in Ecology and the Environment*, *8*(1), 35–43.

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Adaptation Category	Adaptation Strategy	Specific Adaptation Actions
Engage coordination	Improve watershed health and functioning	• Develop partnerships with university programs that focus on hydrology, groundwater, and/or watersheds[1] • Develop partnerships with recreation users to educate and enhance public understanding of watershed health[1] • Incorporate boardwalks and educational features to offer the public information about watershed health[1]
	Reduce illegal take from springs	• Work with enforcement agencies to identify and eliminate instances of illegal take from springs[1]

Table 2 identifies the key riparian habitat vulnerabilities that may be reduced and/or addressed by various adaptation actions. These linkages are based on expert opinion.

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, trail or road decommissioning may benefit aquatic systems by limiting erosion impacts but could also remove important access points to fire-prone areas. For more information about riparian habitat adaptation strategies and actions developed by participants during the workshop, including where and how to implement adaptation actions, implementation timeframe, collaborations and capacity required, and secondary effects on other resources (both positive and negative), please see the report *Climate Change Adaptation Strategies for Focal Habitats of Southern California*.

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Table 2. Key vulnerabilities of riparian habitats linked to specific adaptation actions and management activities; 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 transition. Adaptation actions aimed at increasing knowledge and engaging coordination are not included in this table as they address vulnerability indirectly. Adaptation actions listed in this table include those identified by participants, in the scientific literature, and in other similar efforts.

Management Activity	Adaptation Actions	Climate Stressors			Disturbance Regimes		Non-Climate Stressors				
		Altered precipitation (timing & amount); ↓Soil moisture; ↑Drought;	↓Stream flows	↑Air temperature	↓Snowpack; Earlier timing of snowmelt/runoff	↑Flooding & erosion	Altered wildfire regimes	Dams & water diversions	Invasive species	Land use change	Recreation & transportation corridors	Grazing
Habitat Management & Restoration Activities	Establish wilderness areas, focusing on intact riparian habitat								✔		
	Use vegetation to increase shading of riparian habitat and maintain cool, wet areas	✔	✔	✔							
	Upgrade road crossings (e.g., install higher-capacity culverts) in areas that are prone to sedimentation and/or provide habitat for sensitive species	✔		✔	✔						
	Remove invasive, water-consuming plants	✔				✔		✔			
	Manage invasive species that may increase during drought events (e.g., grasses, bullfrogs)	✔						✔			
	Restore floodplain function by establishing setbacks, stabilizing banks and headcuts, and employing plug-and-pond techniques to support current and future hydrology	✔			✔		✔	✔	✔	✔	
	Remove or modify infrastructure to allow channel migration within the floodplain	✔			✔		✔		✔	✔	
	Enhance breeding sites by providing microhabitat structure (e.g., woody debris) for nesting and egg deposition		✔				✔				
	Collect seeds from plants that have high value to wildlife and will be viable in the future	✔	✔	✔							
	Collect seeds from various locations and elevation bands, prioritizing species that are expected to tolerate future climate conditions	✔	✔	✔							
	Perform re-growth experiments to ensure that proper habitat restoration techniques are being used	✔	✔	✔							
	Focus amphibian conservation activities in areas identified as climate refugia and/or areas that may be suitable habitat in the future	✔	✔	✔	✔						
	Explore the potential for assisted translocation of obligate riparian species to suitable future habitat	✔	✔	✔							
	Protect networks of riparian habitat to create corridors for wildlife movement	✔	✔	✔			✔		✔		
Grazing Management Activities	Use low-density grazing to prevent woody plant encroachment and reduce non-native herbaceous species in meadows	✔						✔			✔
	Focus grazing on non-native species in spring and prevent grazing on native species in summer							✔			✔
	Build livestock exclosures to protect riparian habitats that are easily damaged by grazing										✔
	Implement moderate grazing around vernal pools to maintain vernal pool hydrology	✔									✔
Recreation and Public Use Management Activities	Redesign trail system infrastructure to minimize impacts from trails in popular areas									✔	
	Barricade roads as needed to protect riparian systems									✔	
	Upgrade road crossings (e.g., install higher-capacity culverts) in areas that are prone to sedimentation and/or provide habitat for sensitive species									✔	
	Assess the location of roads and consider removing those within sensitive riparian systems				✔					✔	
	Decrease the number of permits for water extraction	✔		✔			✔				
	Do not renew expired permits for water extraction	✔		✔			✔				

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In addition to directly reducing vulnerabilities (Table 2), some adaptation actions may indirectly address vulnerabilities. For example, establishing wilderness areas that include intact riparian habitat may protect important climate refugia that could protect some wildlife and plant species from stressors such as heat, drought, and flooding. Similarly, planting vegetation to increase shade may also stabilize streambanks, preventing erosion during large flood events.

Two other important considerations when selecting adaptation actions for implementation include feasibility (action capable of being implemented) and effectiveness (action reduces vulnerability). 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.

Figure 1 plots adaptation actions listed in Table 1 according to feasibility and effectiveness. This figure 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 the removal of dikes or recharge basins with the goal of restoring fluvial processes?
- **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 grazing continue in areas with drought-sensitive vegetation?

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.

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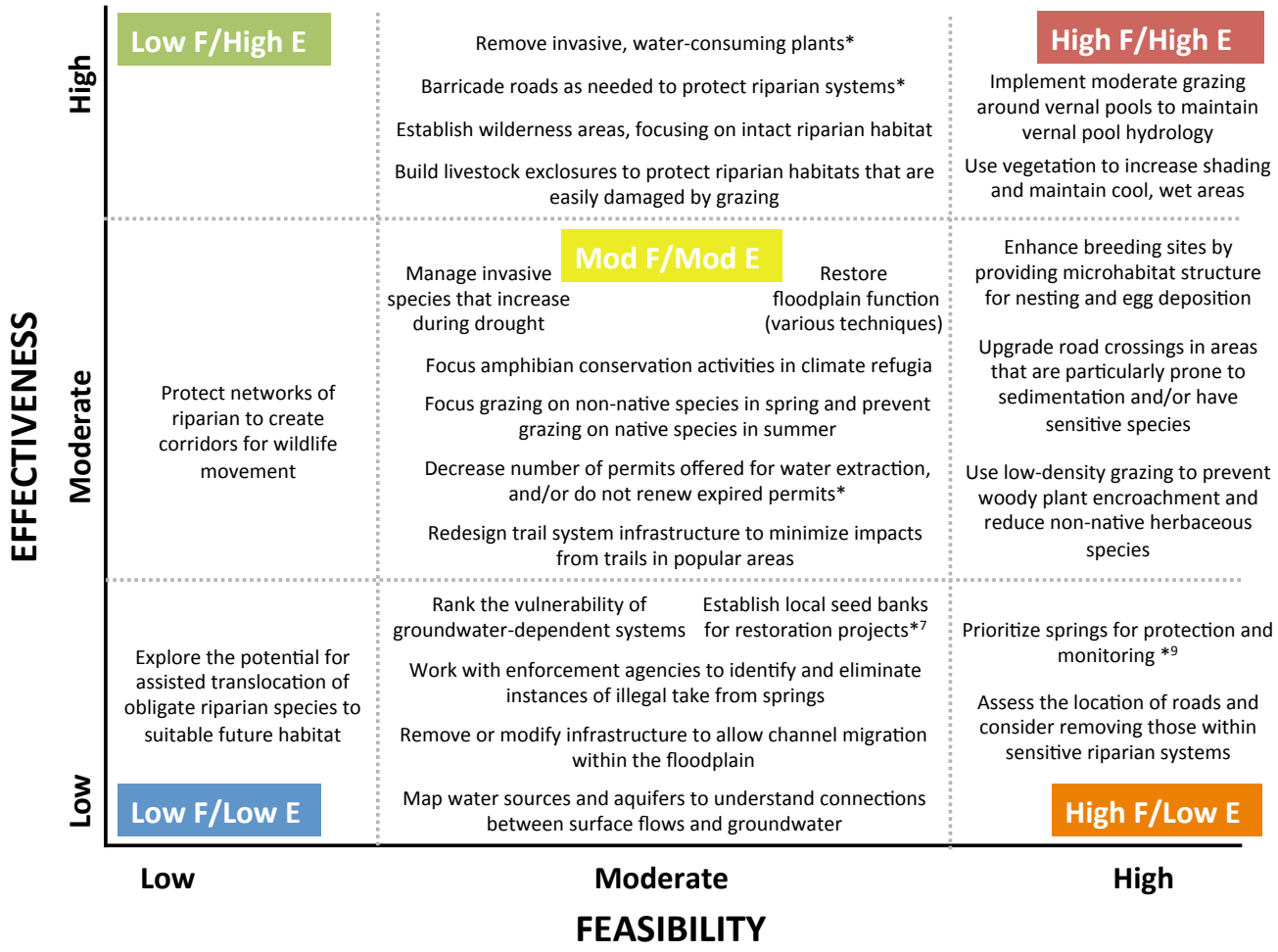

Figure 1. Riparian habitat adaptation actions plotted according to implementation feasibility (action capable of being implemented) and effectiveness (action reduces vulnerability). Those actions having high feasibility and effectiveness appear in the upper right corner and low feasibility and effectiveness in the bottom left corner. An asterisk (*) denotes adaptation actions evaluated for feasibility and effectiveness by workshop participants, although in some cases the ranking was shifted based on expert opinion. All other adaptation action evaluations are based on expert opinion.

Recommended Citation

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[7] This overall goal includes several specific adaptation actions (see Table 1).

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