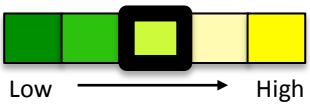
Southern California River and Stream Habitats

Climate Change Adaptation Actions Summary

An Important Note About this Document: *This document represents an initial effort to identify adaptation actions for river and stream 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 river and stream habitats in response to climate change.*

River and Stream Habitat Vulnerability

Moderate Vulnerability



The relative vulnerability of rivers and streams in southern California was evaluated to be moderate by habitat experts due to moderate-high sensitivity to climate and non-climate stressors, moderate exposure to future climate changes, and moderate adaptive capacity. Rivers and streams are sensitive to climate drivers that alter hydrology, water temperature, and water quality. Patterns of high and low streamflows, flooding, and drying are primarily responsible for the dynamic nature of lotic systems. Rivers and streams in southern California already reflect highly variable flow regimes; however, extreme flooding and/or drought events may magnify many processes in the system (e.g., channel incision). Extensive habitat alteration due to non-climate stressors such as dams and water diversions is likely to exacerbate the impacts of climate change. Rivers and streams are considerably degraded throughout most of the region, and hydrologic connectivity is low. This habitat type is adapted to high levels of variability and frequent disturbances, and can recover relatively quickly under natural conditions. However, highly modified streams are slow to recover and are vulnerable to impacts from additional stressors (e.g., invasive species). Overall, rivers and streams are diverse habitats and host many threatened, endangered, and endemic species. Stream improvements and restoration activities could reduce the impact of climate and non-climate stressors and enhance habitat quality.

Adaptation Strategies and Actions

Table 1 presents a summary of possible adaptation strategies and actions for river and stream 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.
4. **Increase Knowledge**. These strategies are aimed at gathering more information about climatic 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 river and stream habitats.

Adaptation Category	Adaptation Strategy	Specific Adaptation Actions
Enhance resistance	Protect streams down-gradient of State Water Project (SWP) lakes/dams	• Continue with dam releases to maintain flows downstream of SWP lakes/dams[1] • Monitor water supply in SWP lakes and reservoirs[1]
	Manage invasive species	• Remove arundo and tamarisk to reduce competition with native species for water[1]
	Restore native species to disturbed areas	• Plant native species in riparian areas after disturbances (e.g., wildfire, infrastructure improvements)[2]
	Increase the resistance of roads and other infrastructure to high peak flows and flooding at stream crossings	• Identify roads within high-priority ecological areas that are most at-risk for future flooding and determine whether those roads can be improved or decommissioned[3] • Plant vegetation near infrastructure to stabilize banks[4]
	Protect rivers and streams from heavy public use	• Examine current recreational use of lakes, rivers, and streams and identify alternatives if needed[1] • Educate recreational users about water conservation and river/stream protection[1]
	Improve water quality by reducing sedimentation	• Optimize grazing management practices to reduce sediment production[2] • Manage vegetation (e.g., mechanical treatments) to reduce fire severity and subsequent erosion and sedimentation[2]
Promote resilience	Reconnect streams to allow the movement of sediment and aquatic organisms	• Remove or replace perched ford stream crossings with bottomless arch culverts or bridges in Core 1 watersheds[1]
	Increase resilience of trail system to higher peak flows by addressing areas with high demands for access	• Upgrade trail bridges with rot-resistant materials[2] • Reroute trails above waterways with high flood risk[2] • Convert road/trail use to other transportation modes (e.g., from vehicle to bicycle or foot)[2]
Facilitate transition	Identify and protect refugia	• Designate conservation easements to extend riparian buffers along rivers and streams[2]
Increase	Monitor species at risk of decline under future climate conditions	• Monitor steelhead density, augmenting the dataset with data collected by the CA Dept. of Fish & Wildlife

[1] Denotes adaptation action identified by workshop participants.
[2] Actions were sourced from the Climate Adaptation Project for the Sierra Nevada and/or the Northern Rockies Adaptation Partnership.
[3] Luce, C. H., Rieman, B. E., Dunham, J. B., Clayton, J. L., King, J. G., & Black, T. A. (2001). Incorporating aquatic ecology into decisions on prioritization of road decommissioning. *Water Resources Impact*, *3*(3), 8–14.
[4] Griggs, F. T. (2009). *California riparian habitat restoration handbook, second edition*. Chico, CA: River Partners.

Adaptation Category	Adaptation Strategy	Specific Adaptation Actions
knowledge		and the National Marine Fisheries Service[1]
Increase knowledge (con't)	Build an information base for timely response to future disturbance events (e.g. flooding, pollution, fire)	• Continue installing and monitoring river/stream gages and snotel sites and consider additional needs for monitoring data (e.g., precipitation)[2] • Develop a database of pre-disturbance data on stream and riparian conditions, including the locations of high-quality habitat most in need of protection[2] • Prioritize data collection based on forecasted drought[2] • Incorporate water flow information into integrated watershed management plans[2]
	Inventory stream characteristics to determine potential climate change impacts	• Inventory and map pools, runs, riffles, creeks, and streams, including non-native plant locations, species use, and species composition[1]
	Increase knowledge of groundwater resources	• Enhance streamflow and groundwater monitoring to obtain real-time data and improve understanding of surface water-groundwater interactions[2]
	Increase knowledge of existing built resources	• Create geospatial database of culverts and bridges[2]
Engage coordination	Increase partnerships to facilitate the protection of aquatic ecosystems	• Increase coordination among partners for aquatic organism passage projects to improve cooperation and leverage funding and local knowledge[1] • Integrate planning efforts among multiple agencies, including fire prevention and management, road management, aquatic restoration, and fisheries and wildlife management[1]
	Minimize risks to human safety	• Communicate risk of high peak flows and flooding to public and private stakeholders[2] • Evaluate and monitor patterns of visitor use relative to hydrological dynamics[2] • Limit visitor access to sites when safety is a concern[2]

Table 2 identifies the key river and stream 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 river and stream habitat 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*.

Table 2. Key vulnerabilities of river and stream 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	↑Flooding & erosion	Altered wildfire regimes	Dams & water diversions	Invasive species	Recreation & transportation corridors	Grazing
Habitat Management & Restoration Activities	Continue with dam releases to maintain flows downstream of SWP lakes/dams	✔	✔			✔	✔		
	Monitor water supply in SWP lakes and reservoirs	✔	✔			✔			
	Remove arundo and tamarisk to reduce competition with native species for water	✔	✔				✔		
	Plant native species in riparian areas after disturbances (e.g., wildfire, infrastructure improvements)			✔	✔	✔	✔		
	Identify roads within high-priority ecological areas that are most at-risk for future flooding and determine whether those roads can be improved or decommissioned			✔				✔	
	Plant vegetation near infrastructure to stabilize banks			✔					
	Optimize grazing management practices to reduce sediment production			✔					✔
	Manage vegetation (e.g., mechanical treatments) to reduce fire severity and subsequent erosion and sedimentation			✔	✔				
	Remove or replace perched ford stream crossings with bottomless arch culverts or bridges in Core 1 watersheds	✔	✔	✔				✔	
	Designate conservation easements to extend riparian buffers along rivers and streams	✔	✔	✔					
Recreation and Public Use Management Activities	Examine current recreational use of lakes, rivers, and streams and identify alternatives if needed							✔	
	Educate recreational users about water conservation and river/stream protection	✔	✔					✔	
	Upgrade trail bridges with rot-resistant materials			✔				✔	
	Reroute trails above waterways with high flood risk		✔	✔				✔	
	Convert road/trail use to other transportation modes (e.g., from vehicle to bicycle or foot)							✔	

In addition to directly reducing vulnerabilities (Table 2), some adaptation actions may indirectly address vulnerabilities. For example, designating conservation easements to extend riparian buffers would likely reduce the impact of multiple non-climate stressors by limiting anthropogenic activity. Similarly, converting roads and trails to other transportation modes (e.g., limiting vehicle traffic and allowing only bicycles and pedestrians) may decrease erosion and sedimentation; this may also reduce additional stressors often associated with transportation corridors, such as the spread of invasive species and wildfire ignitions.

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.

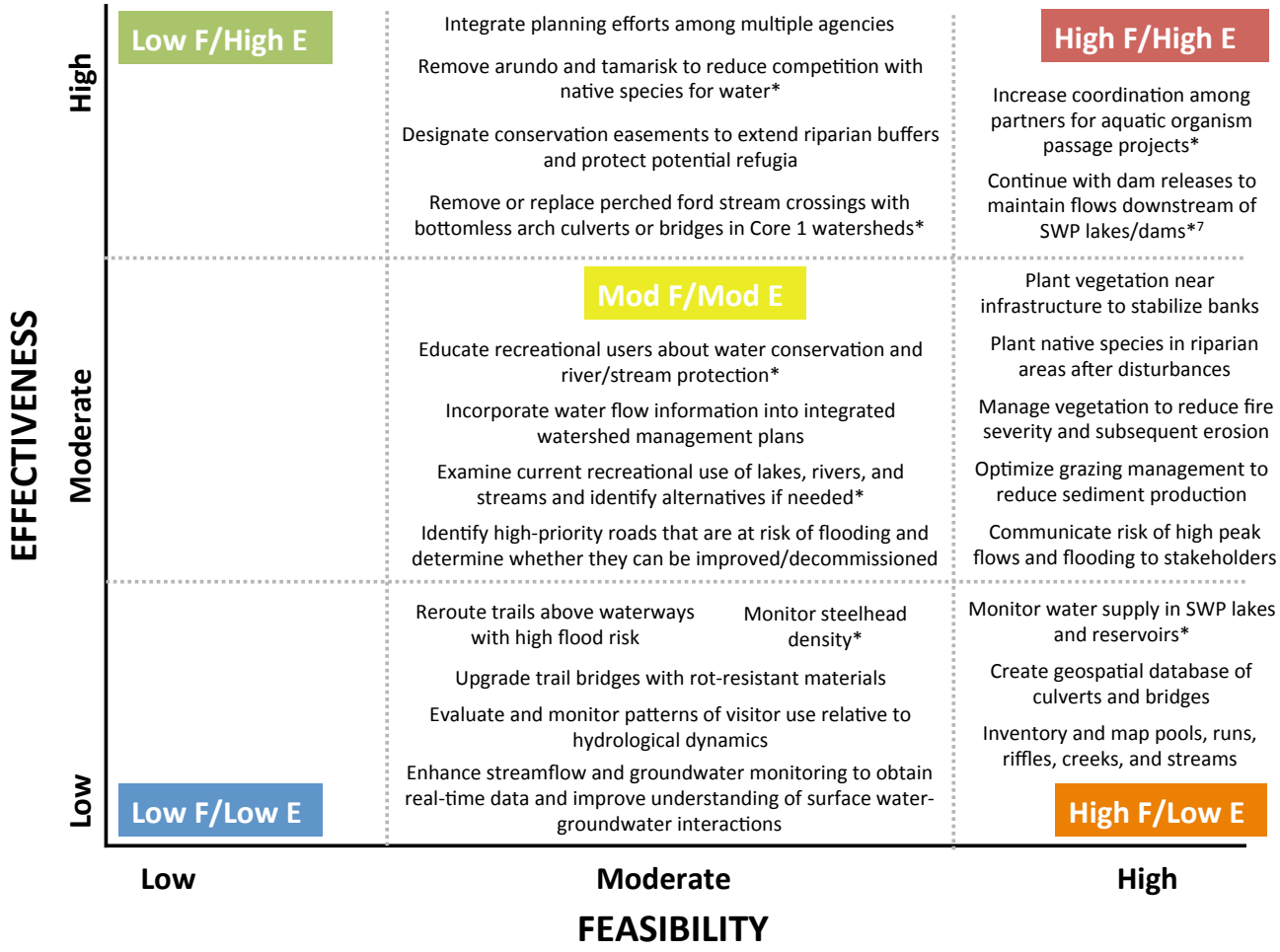


Figure 1. River and stream habitat adaptation actions plotted according to implementation feasibility (action capable of being implemented) and effectiveness (action reduces vulnerability). Those actions having high feasibility and effectiveness appear in the upper right corner and low feasibility and 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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This document is available online at the EcoAdapt website (http://ecoadapt.org/programs/adaptation-consultations/socal).

[5] Workshop participants noted that although this action has high feasibility, it does require regulatory approval.