

FISHERIES

Type of strategy	General adaptation approach	Specific adaptation action
Enhance Resistance (or Reduce Non-Climate Stresses)	Prevent / remove invasive non-native fish	Remove or control non-native fish species
		Strategically use barriers to prevent further spread of non-native fish
		Model future changes in stream flow and habitat to anticipate future invasion hotspots, and consider using information from surveys in warmer basins as indicators of vulnerability or risk
	Maintain/enhance riparian vegetation to shade streams and buffer warming stream temperatures	Reduce grazing pressure (e.g., reduce stocking rates, fence riparian areas, provide off-stream water sources)
		Restore riparian vegetation in degraded areas
	Manage upland vegetation to retain water and snow in order to slow spring snowmelt and runoff	Increase forest cover to retain snow and decrease snowmelt
		Restore mid- and high-elevation wetlands that have been altered by land use
	Increase population resilience by increasing native fish health	Consider changes in hatchery practices
		Survey fish health conditions
		Direct treatment or removal of infected fish
	Increase resilience of native fish populations to warming stream temperatures and flow changes	Replicate and supplement native fish populations
		Consider altering fishing regulations in high priority areas
		Establish large-scale reserves for long-term native cold-water fish conservation
	Increase resilience of native fish species by reducing barriers to native species movement	Replace or retrofit culverts that will not function well during future low base flows and flood periods
		Identify, prioritize, and remove barriers (natural and man-made) to native fish movements
	Increase spawning habitat resilience by restoring stream and floodplain structure and processes	Restore stream and floodplain complexity
		Provide alternative habitat for spawning and increase protection of these areas

Promote Resilience	processes	Increase use of engineered log jams where feasible
	Increase habitat resilience by reducing threats from roads and infrastructure in the floodplain	Designate and restore natural floodplain boundaries
		Increase and/or reconnect floodplain habitat
		Remove infrastructure from floodplains, and reduce road density near streams
		Increase culvert capacity
		Disconnect roads from streams
	Increase aquatic habitat resilience to low summer flows	Increase off-channel habitat and protect refugia in side channels and channels fed by wetlands
		Protect wetland-fed streams that maintain higher summer flows
		At stream crossings, design channels to provide a deep thalweg for fish passage during low-flow periods
	Maximize water storage and late season return flows to streams	Increase storage of water in floodplains by encouraging natural flooding and groundwater infiltration
		Reintroduce beaver and/or install artificial beaver-mimic dams
		Restore wetlands
	Increase in-stream summer flows by reducing withdrawals	Increase efficiency of irrigation techniques
		Reduce summer withdrawals on USDA FS and NPS lands
		Consider alternative water supplies for USDA FS and NPS operations to retain in-stream flows
		Legally secure water rights/agreements for in-stream flow
		Reform water laws to enable increased acquisition of in-stream water rights
Increase efficiency of residential water delivery and use		
Extend voluntary drought-response plans where users reduce their water use during times of drought		
Use water pricing to encourage water conservation		
	Reduce sediment input to streams by replacing culverts, and relocating and decommissioning roads (e.g., in riparian corridors)	

	Reduce sedimentation associated with erosion and fire	<p>Develop a geospatial layer of debris flow potential for pre-fire planning</p> <p>Restore and revegetate burned areas to store sediment and maintain channel geomorphology</p> <p>Include climate change projections in identification of potential streams for stream bank and upland erosion</p> <p>Inventory disturbed areas for candidate sites for riparian and upland vegetation restoration</p> <p>Manage fire and fuels with thinning and prescribed fire to reduce fire severity and extent</p> <p>Link stream inventory with topographic, geomorphic, and vegetation layers to assess existing hazard and risk</p>
Facilitate Transition	Develop a region-wide, spatially explicit climate adaptation strategy for focal fish species	<p>Identify highest priority conservation and restoration sites for focal fish species</p> <p>In the highest priority conservation/restoration sites, survey and evaluate existing management to anticipate and plan for both potential conflict and opportunities for collaboration</p>
	Facilitate change to desired assemblages and/or future locations	<p>Identify and restore “warm-adapted” populations of native trout</p> <p>Connect current populations with streams that are currently too cold (and may warm to suitable levels in the future)</p> <p>Adjust which plants are used for riparian restoration to favor species that are better suited for future climate conditions</p>
	Explore possible water conservation alternatives	<p>Explore the use of water trusts/funds to increase investments in the protection of watershed health and function</p> <p>Explore potential to combine sprinkler and flood irrigation to capture increasing spring floods (and recharge groundwater supplies) and then switch to more efficient sprinkler irrigation when stream flows are lower</p>

Increase Knowledge	Monitor changes in aquatic food web dynamics	Assess food webs for baseline data
		Monitor food web dynamics for changes with warming
	Develop and implement coordinated fish monitoring strategy and database	Identify focal fish species spawning/rearing distributions, and create a monitoring network that can efficiently monitor if/when distributions shift or are lost
		Expand existing inventory/monitoring of native trout and develop a consistent, statistically based assessment of hybridization
		Assess status of non-native fish more frequently to better detect changes in invasions (perhaps using citizen science)
		Monitor changes in stream temperature for fish distributions
	Increase knowledge of patterns, characteristics, and rates of change in species distributions and/or environmental changes	Conduct field experiments of fish-temperature relationships for multiple species and regions
		Evaluate road system for sediment input
		Survey and map non-native species and combine non-native mapping with information on migration barriers
Engage Coordination	Engagement aimed at broadening the implementation of adaptation strategies for fish	Engage diverse water users to develop a holistic adaptation plan
		Engage NRCS in encouraging climate adaptation strategies on private lands
	Increase population resilience by increasing native fish health	Collaborate and standarize health survey methods among agencies
		Increase public education to eliminate disease vectors